CHINA RAILWAY DESIGN CORPORATION
КОСТЕ РАЦИНА 166, 11000 БЕОГРАД
САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о.
11000 БЕОГРАД, НЕМАЊИНА 6/IV
тел: 011/3618-134, факс: 011/3618-324,
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2/1.1.17.1 НАСЛОВНА СТРАНА

2/1. ПРОЈЕКАТ КОНСТРУКЦИЈА

Инвеститор:	„Инфраструктура Железнице Србије“ а.д. Немањина 6/4, Београд
Наручилац:	Конзорцијум фирми: China Railway International Corporation Ltd. China Communication Construction Company Ltd. (CCCC)
Објекат:	Пруга Београд - Суботица државна граница (Келебија), **ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА),** у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци
Врста техничке документације:	**ПГД-** Пројекат за грађевинску дозволу
Назив и ознака дела пројекта:	**ПРОЈЕКАТ КОНСТРУКЦИЈА** **2/1.1.17 Пројекат надвожњака на км 102+390.98**
За грађење / извођење радова:	Нова градња
Пројектант:	China Railway Design Corporation Serbia Ogranak Beograd Косте Рацина 16б 11000 Београд, Србија
Одговорно лице пројектанта:	Генерални директор: 耿欣 (Генг Ксин)
Потпис:	XIN GENG Digitally signed by XIN GENG Date: 2021.08.03 09:21:58 +02'00'
Одговорни пројектант:	Зоран Луковић, дипл. грађ. инж. Лиценца број: 310 3032 03
Потпис:	ЗОРАН ЛУКОВИЋ 011041396 Sign Digitally signed by ЗОРАН ЛУКОВИЋ 011041396 Sign Date: 2021.08.01 12:43:12 +02'00'
Број дела пројекта:	2020-001-ГС-2/1.1.17
Место и датум:	Београд, април 2021.год.

ТЕХНИЧКА КОНТРОЛА ПРОЈЕКТА ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

2/1-1.17 ПРОЈЕКАТ НАДВОЖЊАКА НА km 102+309.98

Објекта: Пруга Београд - Суботица - државна граница (Келебија), **ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)**, у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци, на основу Закона о планирању и изградњи („Службени гласник РС” бр. 72/09, 81/09 – исправка, 64/10 – одлука УС, 24/11, 121/12, 42/13 – одлука УС, 50/13 – одлука УС, 98/13 – одлука УС, 132/14, 145/14, 83/18, 31/19, 37/19 - др. Закон, 9/20 и 52/21) и одредби Правилника о садржини, начину и поступку израде и начину вршења контроле техничке документације према класи и намени објеката (“Службени гласник РС”, бр. 73/2019), извршена је техничка контрола предметне документације, од стране предузећа CESTRA d.o.o. Београд.

ПРОЈЕКАТ СЕ ПРИХВАТА

Вршилац техничке контроле: CESTRA d.o.o,
Макензијева 57, Београд

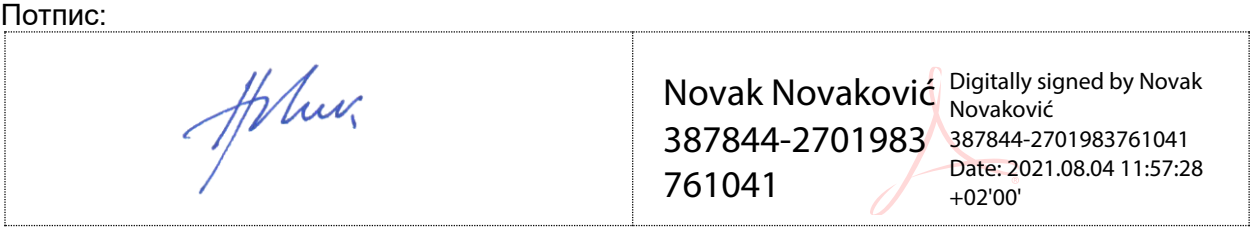
Број лиценце: 351-02-03374/2020-09 од 18.03.2021.

Одговорно лице/Заступник: Директор:
Драган Милић, дипл.грађ.инж.

Потпис:

Вршилац техничке контроле: Драган Милић, дипл.грађ.инж.
Број лиценце: 312 E503 07
Потпис:

Вршилац техничке контроле: Новак Новаковић, дипл.грађ.инж.
Број лиценце: 310 K201 11
Потпис:



Број техничке документације: A10312-61/21

Место и датум: Београд, 2021.

2/1.1.17.2. САДРЖАЈ ПРОЈЕКТА НАДВОЖЊАКА НА КМ 102+309.98

2/1.1.17.1	Насловна страна	
2/1.1.17.2	Садржај	
2/1.1.17.3	Решење о одређивању одговорног пројектанта	
2/1-1.17.4	Изјава одговорног пројектанта	
2/1.1.17.5	Текстуална документација	
2/1.1.17.5.1	Технички опис	
2/1.1.17.6	Нумеричка документација	
2/1.1.17.6.1	Статички прорачун	
2/1.1.17.6.2	Предмер и предрачун	
2/1.1.17.7	Графичка документација	
2/1.1.17.7.1	Основа, уздужни пресек, КПП, пресеци	1:200/100/50
2/1.1.17.7.2	Изглед	1:50
2/1.1.17.7.3	План каблова	1:200

2/1.1.17.3. РЕШЕЊЕ О ОДРЕЂИВАЊУ ОДГОВОРНОГ ПРОЈЕКТАНТА

На основу члана 128а, Закона о планирању и изградњи ("Службени гласник РС", бр. 72/09, 81/09-исправка, 64/10- одлука УС, 24/11, 121/12, 42/13-одлука УС, 50/13-одлука УС, 98/13-одлука УС, 132/14, 145/14, 83/2018, 31/2019, 37/2019 - др.закон и 9/2020) и одредби Правилника о садржини, начину и поступку израде и начину вршења контроле техничке документације према класи и намени објеката ("Службени гласник РС", бр. 73/2019) као:

О Д Г О В О Р Н И П Р О Ј Е К Т А Н Т

за израду **ПРОЈЕКТА КОНСТРУКЦИЈА 2/1.1.17 Пројекат надвожњака на km 102+309.98**, који је део ПГД - Пројекта за грађевинску дозволу Модернизација, реконструкција и изградња пруге Београд - Суботица државна граница (Келебија), деоница пруге Нови Сад - Суботица - државна граница (Келебија), у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач,, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас- АТАР, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, одређује се:

Зоран Луковић, дипл.грађ.инж. _____310 3032 03

Пројектант:	CHINA RAILWAY DESIGN CORPORATION SERBIA OGRANAK BEOGRAD, Косте Рацина 16б
Одговорно лице/заступник:	Генерални директор: Генг Ксин, дипл.инж.
	Потпис:
Број техничке документације:	2020-001-ГС-2/1.1.17
Место и датум:	Београд, април 2021.год.

2/1-1.17.4. ИЗЈАВА ОДГОВОРНОГ ПРОЈЕКТАНТА

Одговорни пројектант пројекта **ПРОЈЕКАТ КОНСТРУКЦИЈА 2/1.1.17 Пројекат надвожњака на km 102+309.98** који је део ПГД - Пројекта за грађевинску дозволу Модернизација, реконструкција и изградња пруге Београд - Суботица државна граница (Келебија), деоница пруге Нови Сад - Суботица - државна граница (Келебија), у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач,, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас- АТАР, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град:

Зоран Луковић, дипл. грађ.инж.

И З Ј А В Љ У Ј Е М

1. да је пројекат у свему у складу са издатим Локацијским условима:
-Бр.:ROP-MSGI-28188-LOCH-4/2020, заводни број: 350-02-00031/2020-14 од 06.04.2020,
-Бр.:ROP-MSGI-7141-LOC-1/2020, заводни број: 350-02-00109/2020-14 од 08.05.2020
-БР.ROP-MSGI-28188-LOCH-4/2020, Заводни број: 350-02-00031/2020-14 од 07.04.2020 - Решење о исправци грешке,
-Бр.:ROP-MSGI-931-LOCA-3/2020 Заводни број: 350-02-00192/2020-14 од 29.05.2020, издатим у МГСИ,
2. да је пројекат израђен у складу са Законом о планирању и изградњи, прописима, стандардима и нормативима из области изградње објеката и правилима струке,
3. да је пројекат у свему у складу са начинима за обезбеђење испуњења основних захтева за објекат прописаних елаборатима и студијама.

Одговорни пројектант:	Зоран Луковић, дипл. инж. грађ
Број лиценце:	310 3032 03
	Потпис:
Број техничке документације:	2020-001-ГС-2/1.1.17
Место и датум:	Београд, април 2021.год.

2/1.1.17.5
ТЕКСТУАЛНА ДОКУМЕНТАЦИЈА

2/1.1.17.5.1
ТЕХНИЧКИ ОПИС

ТЕХНИЧКИ ОПИС

1. УВОД

Деоница пруге Нови Сад-Суботица-државна граница (Келебија) представља трећу деоницу пруге Београд-Суботица-државна граница (Келебија).

На новој траси двоколосечне пруге Нови Сад - Суботица (мађарска граница), пројектованој за брзину од 200 km/h, уместо постојећег путног прелаза у нивоу, пројектован је нови друмски надвожњак на стационажи пруге км 102+309.98, десног колосека.

У пројектном задатку није дефинисана класа значаја за мостове. Пројектант је усвојио следеће: класу објекта II, то јест коефицијент значаја 1,0 за друмске мостове.

2. САОБРАЋАЈНИ УСЛОВИ

Надвожњак је предвиђен за двосмерни саобраћај где сваки смер има по једну коловозну траку ширине 3.25m и једну службену стазу. Осовина објекта је облика „S“ кривине. Пешачке (сервисне) стазе су ширине 0.75m лево и 2.0m десно. Попречни нагиб пешачких стаза је ка коловозу и износи 4%. Укупна ширина објекта је 11.15m. Нивелета моста од S1 до S7 је у подужном паду 4%, а од S7 до S13 у вертикалној кривини од 1250. Попречни пад коловоза износи 4,0% на почетку моста до -3.0% на крају моста

Укрштање левог колосека пруге и надвожњака је на стационажи км. 102+309.98.

3. ДИСПОЗИЦИЈА МОСТА

Надвожњак се уклапа у геометрију пута и прелази преко двоколосечне пруге, што диктира положај и оријентацију стубова, као и распоне објекта.

Надвожњак се састоји из две дилатационе целине. Прва је од стуба S1 –S7, друга од S7-S13.

Прва и друга дилатациона средина се састоје од шест поља (17,10 + 5 x 22,10m + 5 x 22,10 + 17,10)

Укупнадужина надвожњака са свим дилатационим целинамаизноси 256.20 m.

Карактеристични попречни пресек надвожњака

Укупна ширина распонске конструкције је 11.15 m и састоји се од:

• Размак од ограде до спољње ивице	2 x 0.25 = 0.50 m
• Сервисна стаза	0.75+2.0 = 2.75 m
• Еластистична одбојна ограда	2 x 0.50 = 1.00 m
• Сигурносни простор до ограде	2 x 0.20 = 0.40 m
• Коловоз	2 x 3.25 = 6.50 m
Укупно:	11.15 m

4. ОПИС КОНСТРУКЦИЈЕ

Конструктивни елементи

Надвожњак се састоји од две полуинтегралне конструкције.

Распонска конструкција је пуна плоча са конзолама на крајевима и изводи се на лицу места на скели и оплати. На овом делу објекат се налази у значајној кривини и употреба монтажних носача није практична. Са друге стране на овом делу висина објекта изнад терена није велика па је самим тим и израда скеле једноставна. Због малих распона предвиђена је армиранобетонска преднапегнута конструкција.

Стуб S7 је заједнички стуб дилатационих целина. На њему су предвиђена лежишта а конструкције су раздвојене дилатацијама.

Потпорна конструкција

Средњи стубови се састоје од два правоугаона стуба дебљине 80cm и ширине 160cm, на међусобном размаку од 3.40m. Ослањање средњих стубова је извршено преко темељне греде димензија 1.80m x 1.80m, дужине 9.20m.

Обални стубови се састоје од зида опорца дебљине 100 cm, ослоњен на темељну плочу дебљине 1.20м и 6 шипова Ф120 cm. Са горњом конструкцијом је повезан лежиштем.

На оба обална стуба су прикључене прелазне плоче дебљине 25 cm и типске дужине 3,70+2.50 = 6.20 m.

Фундирање

Обзиром на геолошки састав и носивост тла, на присуство подземне воде, а у сагласности са геолошко геотехничким елаборатом, извршено је дубоко фундирање, а усвојену коту фундирања шипова треба да потврди геотехничар приликом ископа. Усвојено је фундирање на бушеним шиповима Ø120 cm.

Фундирање је предвиђено на шиповима дужине 20m.

На средњим стубовима предвиђена су три шипа у једном реду на међусобном размаку од 3.60m і дужине 20.0 m.

На заједничком стубу (S7) предвиђено је три шипа у два реда, што чини укупно шест шипова дужине 20.0 m.

На обалним стубовима предвиђено је три шипа у два реда дужине 20.0m. Шипови су на размаку од 4.0m.

Обзиром на састав тла, шипови ће носити и по бази и по омотачу. Дубина и број шипова је димензионисан тако да максимална сила у шипу буде мања од срачунате носивости шипа.

Испод темељних греда и плоча је предвиђен слој за изравнање од 10 cm, од неармираног бетона C12/15.

Наглавне греде шипова и темељи се затрпавају водонепропусним материјалом, а клин иза крајњих стубова се изводи од шљунковите мешавине, погодне за дренирање подземне воде, набијањем у слојевима од по 30 cm.

Распонска конструкција

Распонска конструкција је пуна плоча дебљине 110 cm. На крајевима су конзоле промењиве дебљине од 45 cm на укљештењу до 22 cm на крајевима. Дужине конзола су по 2.10 m и 3,10 m, што заједно са плочом даје укупну ширину од 10.45 m. Плоча је преднапрегнута конструкција. На средњим стубовима је крута веза док је на заједничким и обалним стубовима ослоњена преко лежишта.

Статички систем

Статички прорачун је спроведен за обе дилатационе целине.

У подужном смислу надвожњак је полуинтегрална конструкција на шест распона.

Хоризонталне силе од сеизмике, силе кочења, температуре, скупљања и течења у правцу подужне осе моста примају сви средњи стубови, док обални и заједнички стуб не примају те утицаје.

Хоризонталне силе од сеизмике и ветра у попречном правцу примају сви стубови.

Елементи коловоза

На припремљену бетонску површину, која је претходно очишћена пескарењем и отпрашивањем путем компресора, наноси се хидроизолација. Преко хидроизолације се наноси коловозни застор.

Коловозна конструкција се састоји из два слоја асфалта. Први, заштитни слој дебљине 3.0cm, је асфалтбетон AB 11S, други хабајући, је асфалтбетон SMA 0/11 дебљине 4.0cm.

Ивичњаци су димензија 20 x 25 cm, висине изнад коловоза 10cm. Ивичњаци се до 0 cm на делу рампи висински прилагођавају попречном профилу трасе аутопута.

Службена стаза је армирано-бетонска, са храпавом горњом површином. Од дејства мраза и соли штити се вишеструким заштитним премазом, отпорним наUV зраке, са могућностима премошћавања пукотина и на температурама испод 0°C, отпорним на дифузију CO_2, водонепропусним, високе отпорности на старење и високе отпорности на хабање и хемијски агресивне утицаје.

Све бетонске површине у додиру са земљом премазују се са два битуменска премаза.

Опрема

Пројектом је предвиђена еластомерна дилатација над заједничким стубом капацитета померања ± 170mm, а над обалним стубовима ±85.

Над заједничким стубом предиђена су по четири лончаста лежишта, подужно померљива.

Еластична одбојна ограда треба да задовољи одредбе прописа EN 1317. На мосту је предвиђена пешачка заштитна ограда са округлим профилима и вертикалном испуном, од поцинкованог челика, висине 110 cm и окцима ширине мање од 12 cm.

На централном распону, изнад пруге, предвиђена је заштитна мрежа.

За пролаз комуналних и других евентуалних водова предвиђене су PVC цеви одговарајућег пречника, које су уграђене у бетон сервисних стаза, а предвиђени су и ревизиони шахтови са челичним поклопцем који служе за контролу инсталација које су уграђене у сервисне стазе.

Сливници на мосту су цевима повезани у затворени систем за одводњавање и испуштају атмосферску воду у кишну канализацију којом иду у систем за пречишћавање. Сливник мора да има одтицајно корито преко кога је могуће наставити хидроизолацију и усмерити процедну воду у сливник.

Бетонске прилазне рампе просечне дебљине 25 cm су армиране конструктивно и обликом се прилагођавају промени висине ивичњака и положају каналета.

Материјали

Пројектом је предвиђено уграђивање бетона следећих карактеристика:

KARAKTERISTIKE MATERIJALA / MATERIALS SPECIFICATION

ELEMENT	Beton/ concrete EN 206-1:2000	Klasa upotrebe/ Exposition class	PV	Betonski čelik/ Concrete steel	Zaštitni sloj/ Concrete cover (cm)
Podbeton/ Lean concrete	C 12/15	X0	/	/	/
Šipovi/ Piles	C 30/37	XC2	PV-I	B500B	min 7.5
Naglavnice/ Pile Caps	C 30/37	XC2	PV-I	B500B	5.0
Obalni stubovi,stubovi i krila/ Abutments, piers and wing walls	C 30/37	XC4, XF1	PV-I	B500B	5.0
Kolovozna ploča/ Deck slab	C 35/45	XC3, XF1	PV-II	B500B	4.0
Prelazna ploča/ Approach slab	C 30/37	XC2	PV-I	B500B	5.0
Pešačke staze/ Walkway and egde beam	C 35/45	XC4, XD3, XF4	PV-II	B500B	5.0
Prednapregnuti kablovi/ Prestressed cables	fpy / fpk = 1670 / 1860 MPa (Ø 15.7 mm)				

Бетони отпорни на мраз и со морају бити припремљени са одговарајућим системом увучених ваздушних пора (додатак аеранта), ниским водоцементним фактором (са суперпластификатором на бази поликарбоксилата), агрегатом ниске потребе за водом и коефицијентом термичке дилатације компатибилномKTD-у цементног камена, правилно уграђени и неговани, са што већим процентом довршене хидратације пре излагања смрзавању. Речни агрегат са претежно кварцним минералима има коефицијент термичке

дилатације приближан КТД-у цементне масе. Бетон носача не сме имати састојке који поспешују корозију ужади за преднапрезање.

Армирање се изводи арматуром B500B, док се преднапрезање изводи ужадима пречника Ø15.7mm, квалитета 1670/1860 MPa са ниском релаксацијом (мах 2,5% након 1000 h).

Квалитет уграђеног материјала мора одговарати важећим стандардима и пре уграђивања морају се приложити докази о квалитету материјала, без којих не сме почети уградња.

5. ТЕХНОЛОГИЈА ГРАДЊЕ

Ископ за темеље стубова и наглавне греде шипова се изводи плитко, машинским ископом темељних јама без посебне заштите. За извођење бушених шипова на осталим стубовима треба обезбедити приступ гарнитуре за бушење. Шипови се бетонирају до нивоа од мин 30 cm изнад врха шипа, с тим да на првом изведеном шипу надвишење буде мин 60 cm. При крајцовању "запрљаног" бетона чувати постављену арматуру.

После постављања слоја подложног бетона, арматуре и оплате, изводе се темељи, наглавне греде шипова и стубови, бетоном ливеним на лицу места уз потребну оплату. После ове фазе могуће је приступити делимичном затрпавању темеља и изради кегли, дренажа и засипа иза крајњих стубова.

Коловозна плоча се бетонира на лицу места уз употребу одговарајуће скеле и оплате.

На потпуно суви и неиспрскали бетон плоче поставља се прајмер и хидроизолација. Потребно је заштитити хидроизолацију моста пре других радова. По постављању ивичњака се бетонирају службене стазе и ивични венци. Следе радови на асфалтирању, постављању ограда и евентуалних инсталација.

6. ИЗМЕНЕ У ОДНОСУ НА ИДЕЈНИ ПРОЈЕКАТ

Концепт моста је задржан као у Идејном пројекту уз одређене ситне измене у циљу усаглашавања пројекта са технологијом извођача, као и оптимизације решења.

1. Промењен је карактеристични пресек моста. За пресек је усвојена преднапрегнута АВ плоча уместо ошупљене преднапрегнуте АВ плоче.
2. Места дилатација су промењена тј. промење су дужине дилатацијских секција.
3. Марка бетона распонсек конструкције је смањена са С40/50 на С35/45.
4. У главном пројекту су лежишта пројектована само на местима обалних и дилатацијских стубова. У идејном пројекту лежишта су била предвиђена на по још једном стубном месту до обалних и дилатацијских.
5. Средњи стубови дилатацијских целина су ослоњени на наглавицу на једном реду шипова у односу на идејни пројекат где су средњи стубови ослоњени на по два реда шипова.

На овај начин пројекат је усаглашен са технологијом извођача и при томе добијена поузданија конструкција једноставнија за одржавање.+

Београд, Април 2021.	Belgrade, April 2021
Одговорни пројектант:	Responsible designer:
Зоран Луковић, дипл.грађ.инж лиценца бр.: 310 3032 03	Zoran Luković , grad.Civ.Eng. Licence no.: 310 3032 03

2/1.1.17.6
НУМЕРИЧКА ДОКУМЕНТАЦИЈА

2/1.1.17.6.1
СТАТИЧКИ ПРОРАЧУН

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1. УВОД

INTRODUCTION

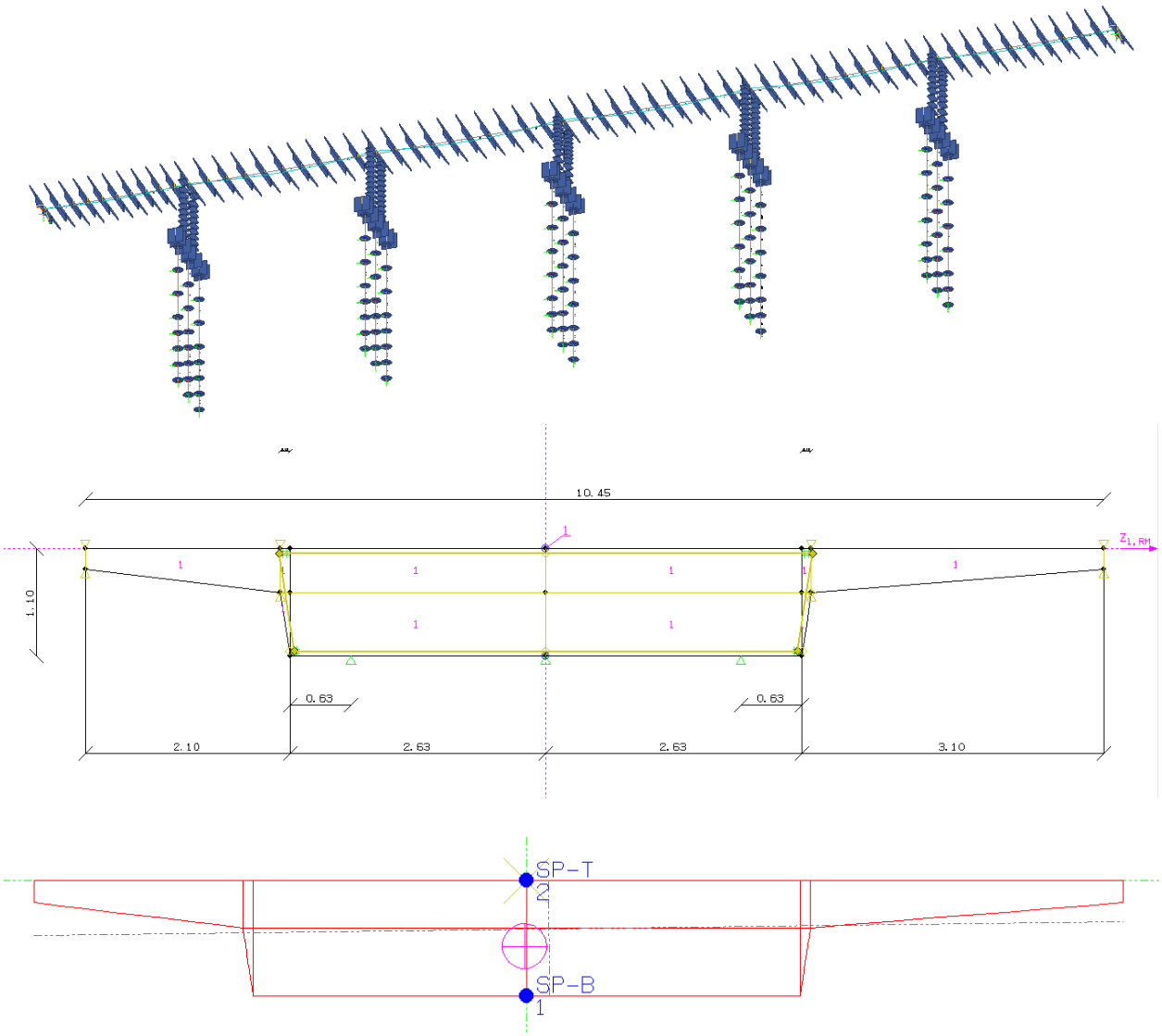
1. УВОД / INTRODUCTION

Надвожњак се састоји од две независне дилатационе целине. Обе дилатационе целине су истог попречног пресека у виду пуне бетонске армиране плоче. Распонска конструкција једне целине је преко шест поља, осовинских распона: 17.10 + 4 x 22.10 + 21.10 = 126.60 m. Статички систем моста је континуални носач са крутим везама на свим средњим ослонцима и лежиштима на крајњим.

The superstructure consists of a two separate units. Both units have the same cross section in the form of reinforced concrete slab. The construction of one unit is over six spans: 17.10 + 4 x 22.10 + 21.10 = 126.60 m. The static bridge system is a continuous girder with rigid connections on all middle supports and bearings on the end supports.

Статички модел и анализа конструкције је урађена са програмским пакетом RM Bridge Advanced V10, тако што је главни носач у подужном смеру моделиран уз следеће елементе: beam (штапови), tendon (каблови), spring elements (везе).

The structure was analyzed using RM Bridge Advanced V10; finite element modeling software specialized for the design of bridges. In the longitudinal direction, the girder is modeled in combination with beam elements (frames), tendons (cables) and spring elements (connections).



Нумерација елемената за прорачунски модел / Numeration of elements for calculation model

Коловозна плоча / Main Girder:

B101-B160

Каблови / Tendons:

Tendon 101
Rezultantni kabl / Resultant cable 10x19Ø15.7

Стубови / Piers:

S2 1201-1210

S3 1301-1312

S4 1401-1411

S5 1501-1512

S6 1601-1611

Лежишне греде / Pile caps:

S2 2201-2207

S3 2301-2307

S4 2401-2407

S5 2501-2507

S6 2601-2607

Лежишта/ Supports:

S1 1101, 1102

S1 1701, 1702

Шипови / Piles caps:

S2 3211-3217, 3221-3227, 3231-3237

S3 3311-3317, 3321-3327, 3331-3337

S4 3411-3417, 3421-3427, 3431-3437

S5 3511-3517, 3521-3527, 3531-3537

S6 3611-3617, 3621-3627, 3631-3637

Опруге на шиповима / Piles springs:

S2 4211-4217, 4221-4227, 4231-4237

S3 4311-4317, 4321-4327, 4331-4337

S4 4411-4417, 4421-4427, 4431-4437

S5 4511-4517, 4521-4527, 4531-4537

S6 4611-4617, 4621-4627, 4631-4637

У улазним подацима су дефинисана сва оптерећења, која су задата на моделу. Иза тога су дефинисане комбинације оптерећења.

All loads assigned to the structural model were defined as part of the input stage, followed by load combinations.

SW-STG1 **Сопствена тежина конструкције** / Self-weight of the structure

PT-STG1 **Преднапрезање каблова** / Post tensioned tendons

SDL **Додатно стално оптерећење** / Superimposed dead load

CS-STG1 **Скупљање и течење конструкције /** Creep and shrinkage, **t=60 дана**
CS-INF **Скупљање и течење конструкције** / Creep and shrinkage, **t=10000 дана**
CS-SUM **Финално оптерећење од скупљања и течења** / Summation of creep and shrinkage, **t=10060 дана**

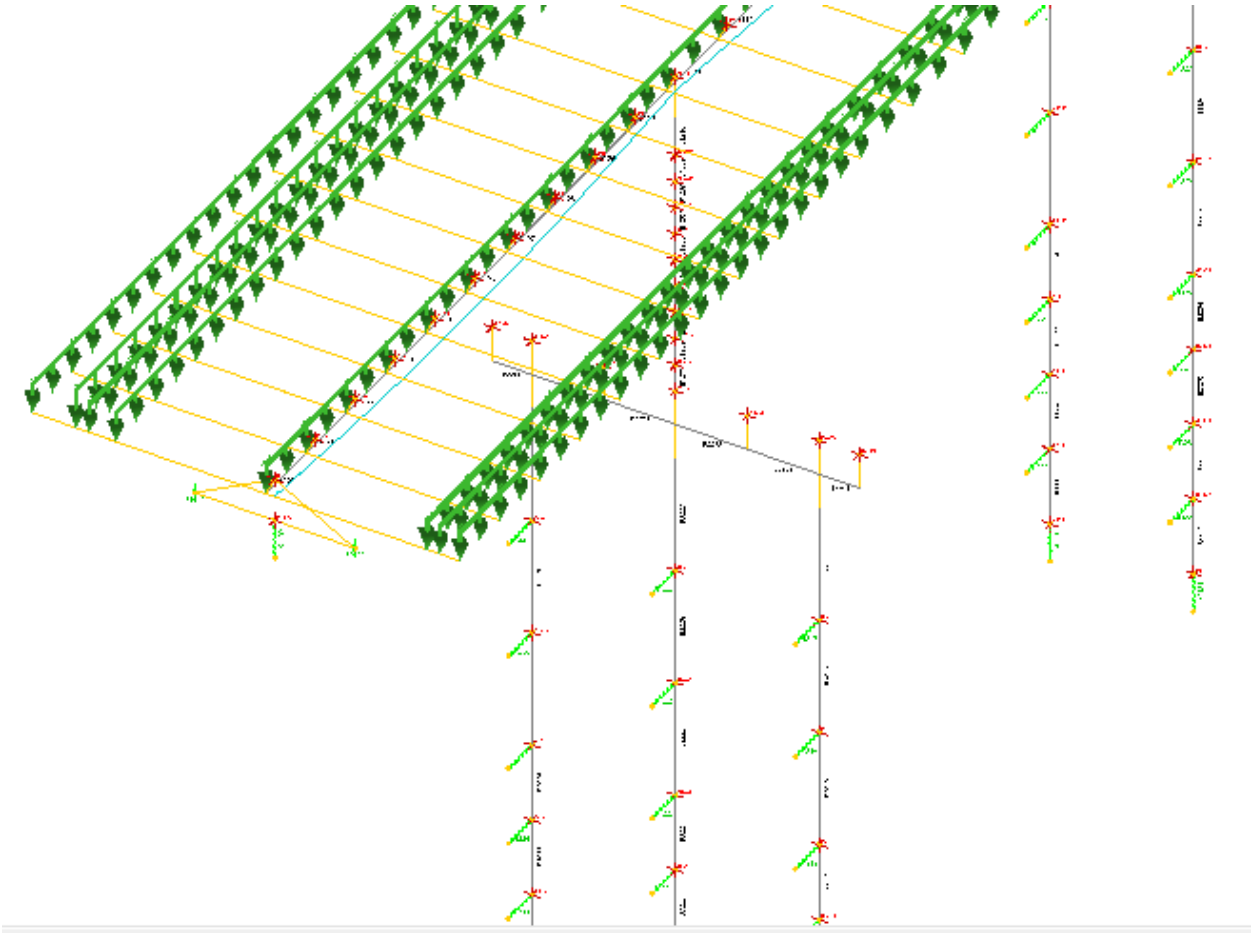
LM1-TS **Покретно оптерећење – концентрисане силе** / Moving load – concentrated loads
LM1-UDL **Покретно оптерећење – Расподељено оптерећење по тракама** / Moving load – uniforml distributed load
LM3 **Покретно оптерећење – покретно оптерећење за контролу замора** / Moving load – fatigue limit state
Brake **Покретно оптерећење – силе покретања и кочења** / Moving load – acceleration and braking forces
WindS+T.sup **Дејство ветра на мост са саобраћајним оптерећењем** / Wind load on traffic
WindS-T.sup **Дејство ветра на мост без саобраћајног оптерећења** / Wind load, without traffic
Temp-U.sup **Униформна температура** / Uniform temperature change
Temp-G.sup **Темепературни градијент** / Temperature gradient
EQ **Сеизмичко оптерећење** / Seismic (earthquake) loads

Стално оптерећење је израчунато у односу на стварну тежину појединих елемента. Запреминска тежина армираног бетона износи γ=25,0 kN/m3. Програм на основу датих запреминских тежина материјала и димензија елемената конструкције израчунава властито оптерећење.

The self-weight of the structure was calculated based on the actual weight of individual elements. The unit weight of reinforced concrete was taken as γ = 25,0 kN/m^3. Based on assigned material properties, unit weights and cross-sections, the self-weight is automatically computed by the software.

Оптерећења која се налазе на главном носачу: дебљина слојева на коловозној плочи (асфалтбетона, хидроизолације...) , сопствена тежине ограде, инсталација је дата као вертикално линијско оптерећење по дужини главних носача.

The following loads were applied to the girder: asphalt , railing etc. was applied as a vertical, uniformly distributed load along the length of the structure.



Корисна рачунска оптерећења су возила модела LM1 са комбинацијом концентрисаних сила и одговарајућим пратећим расподељеним оптерећењем. Оптерећују се две рачунске траке, са силама 300 kN, 200 kN, и силама од 100 kN у свим комбинацијама возила. Програм аутоматски узима у обзир најнеповољнији положај возила, обзиром на положај у попречном смислу који задаје корисник.

The primary moving load consists of Load Model 1 (LM1). This is a combination of a 300 kN double-axle load (referred to as the *Tandem System*) and a uniformly distributed load (referred to as the *UDL System*), applied in each traffic lane. Should there be more than one lane of traffic, the tandem system is reduced in adjacent lanes (i.e. 200 kN in lane 2, or 100 kN). Load model 3 (LM3) was considered as part of the fatigue analysis.

Реологија обухвата дуготрајне процесе скупљања и течења бетона те релаксацију каблова за преднапрезање. Коефицијент течења ϕ(t,t0) и релативне деформације скупљања єцс су узети у складу са прописима за релативну влажност околине 70%. Релаксација ужади за преднапрезање је узета програмски. Прорачун параметара реологије је у складу са редоследом и динамиком грађења и узети су у обзир програмски.

The rheology factor takes into account the creep and shrinkage of concrete, as well as relaxation of pretensioned strands. The creep coefficient $\phi(t,t_0)$ and relative shrinkage strain ε_{cs} were taken in accordance with a relative humidity of 70%. Strand relaxation properties were program-calculated. Rheology parameters were calculated in accordance with the sequence of construction, and were also applied by the program.

Температурни утицаји одређени су на основу улазних параметара: надморске висине, најмање и највеће температуре ваздуха.

Temperature loads were applied in accordance with the following input parameters: elevation above sea level, and total temperature difference between maximum and minimum.

Stage substructure: Izrada substructure

Stage 1: Активациаја сопствене тежине главног носача, утезање каблова, реологија за период од 60 дана.

Activation of the main girder selfweight, cable prestressing, rheology for a period of 60 days.

Final stage: Временски утицаји у плочи, наношење додатног сталног оптерећења. Ова фаза обухвата и прорачун додатног сталног оптерећења, као и реологију бетона за период 10 000дана.

Final stage: Time-dependent effects on the concrete slab and application of superimposed dead load. This phase also encompasses time-dependent effects on concrete for a period t = 10 000 days.

Traffic: Прорачун покретног оптерећења LM1, LM3 (замор)

Traffic: Moving load LM1, LM3 (fatigue)

Temp: Прорачун температурног оптерећења

Temp: Temperature loads

Wind: Прорачун оптерећења од ветра

Wind: Wind loads

EarthQuake: Прорачун сеизмичког оптерећења

EarthQuake: Calculation of seismic (earthquake) loads

Рачунање комбинација / Combination stage: SLS-charac, Frequent, Quasi-permanent, Fatigue, ULS

Контрола допуштених вредности напона / Stresses check design:

FibSup: Гранично стање употребљивости, контрола напона у горњем и доњем влакну
FibSup: Serviceability limit state; calculation of stresses in the top and bottom fibres

CrackSup: контрола прслина – прорачун потребне арматуре за покривање прслина
CrackSup: crack width check – calculation of required reinforcement for preventing crack width opening

Fatigue: контрола замора
Fatigue: fatigue check

PrincSup: контрола главних напона затезања
PrincSup: principal stresses check

Провера носивости / Resistance check

ULScheck: Гранично стање носивости
ULScheck: Ultimate limit state

ShearCheck: Прорачун носивости на смицање
ShearCheck: Shear resistance calculations

2. КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА

MATERIAL PROPERTIES

2. **МАТЕРИЈАЛИ** / MATERIALS

KARAKTERISTIKE MATERIJALA / MATERIALS SPECIFICATION					
ELEMENT	Beton/ concrete EN 206-1:2000	Klasa upotrebe/ Exposition class	PV	Betonski čelik/ Concrete steel	Zaštitni sloj/ Concrete cover (cm)
Podbeton/ Lean concrete	C 12/15	X0	/	/	/
Šipovi/ Piles	C 30/37	XC2	PV-I	B500B	min 7.5
Naglavnice/ Pile Caps	C 30/37	XC2	PV-I	B500B	5.0
Obalni stubovi,stubovi i krila/ Abutments, piers and wing walls	C 30/37	XC4, XF1	PV-I	B500B	5.0
Kolovozna ploča/ Deck slab	C 35/45	XC3, XF1	PV-II	B500B	4.0
Prelazna ploča/ Approach slab	C 30/37	XC2	PV-I	B500B	5.0
Pešačke staze/ Walkway and egde beam	C 35/45	XC4, XD3, XF4	PV-II	B500B	5.0
Prednapregnuti kablovi/ Prestressed cables	fpy / fpk = 1670 / 1860 MPa (Ø 15.7 mm)				

Armatura / Reinforcement EN 10080

B500B
f_{yk}= 500 MPa
$f_{yd}= f_{yk} / \gamma_c$ = 500000 /1,15= 435 MPa
E= 200 000 MPa

Ograničenje napona u armaturi za karakterističnu kombinaciju opterećenja (granična stanja upotrebljivosti)
Reinforcement stress limits for characteristic load combination (service limit state)

0.8 x f_{yk}= 400 MPa

Beton / Concrete EN 206

Klasa čvrstoće / Concrete class C 30/37

Karakteristična čvrstoća betona pri pritisku (cilindar) t=28 dana
Characteristic concrete compressive strength (cylinder) at t=28 days $f_{ck,cyl}$ = 30 000 kN/m^2

Karakteristična čvrstoća betona pri pritisku (kocka) t=28 dana
Characteristic concrete compressive strength (cube) at t=28 days $f_{ck,cube}$= 37 000 kN/m^2

Srednja vrednost čvrstoće pri pritisku t=28 dana
Average compressive strength of concrete at 28 days $f_{cm,28}= f_{ck,cyl}$+8000= 38 000 kN/m^2

Proračunska čvrstoća betona pri pritisku
Design concrete strength $f_{cd}= \alpha_{cc} \times f_{ck,\,cyl} / \gamma_c = 0.85 \times 30\,000 / 1.5 = 17000$ kN/m^2
Donja karakteristična čvrstoća betona na zatezanje (5% fraktil)
Lower characteristic concrete tensile strength (5% fractil) $f_{ctk,0.05}= 2\,000$ kN/m^2

Gornja karakteristična čvrstoća pri zatezanju (95% fraktil)
Upper characteristic concrete tensile strength (95% fractile) $f_{ctk,0.95}= 3\,800$ kN/m^2
Srednja čvrstoća na zatezanje
Average concrete tensile strength $f_{ctm}= 2\,900$ kN/m^2

Srednja vrednost modula elastičnosti betona
Average modulus of elasticity of concrete $E_{cm}= 33\,000\,000$ kN/m^2

Ograničenje napona pritiska u betonu prema EN 1992 za mostove (granično stanje upotrebljivosti) / Concrete compressive stress limits in accordance with EN 1992 for bridges (service limit state)

Ograničenje napona pritiska u betonu radi izbegavanja pojave podužnih prslina i mikroprslina:
Concrete compressive stress limits to avoid longitudinal cracks and microcracks

- **za karakterističnu (retku) kombinaciju opterećenja**
  characteristic load combination $0.6xf_{ck,cyl}= 0.60 \times 30\text{MPa} = 18.0$ MPa
- **pri nanošenju sile prednaprezanja (pre gubitaka) (SRPS EN 1992-1-1 NA 2.40)**
  at the time of prestressing (before losses) $0.7 \times (0.75 \times f_{c,cyl}) = 0.70x(0.75x30) = 15.75$ MPa

Ograničenje (stalnog) napona pritiska u betonu radi izbegavanja nelinearne analize tečenja betona /
Concrete (permanent) compressive stress limits to avoid nonlinear concrete creep analysis

- **za kvazi-stalnu kombinaciju opterećenja**
  quasi-permanent load combination $0{,}45xf_{ck,\,cyl}= 0{,}45 \times 30\,000 = 13\,500$kN/m^2

Ograničenje napona zatezanja u betonu prema EN 1992/ Concrete tensile stress limits in accordance with EN 1992:

- **za karakterističnu (retku) kombinaciju opterećenja**
  characteristic load combination $f_{ctm}= 2\,900$kN/m^2

Klasa čvrstoće / Concrete class C 35/45

Karakteristična čvrstoća betona pri pritisku (cilindar) t=28 dana
Characteristic concrete compressive strength (cylinder) at t=28 days $f_{ck,cyl} = 35\,000$ kN/m^2

Karakteristična čvrstoća betona pri pritisku (kocka) t=28 dana
Characteristic concrete compressive strength (cube) at t=28 days $f_{ck,cube}= 45\,000$ kN/m^2

Srednja vrednost čvrstoće pri pritisku t=28 dana
Average compressive strength of concrete at 28 days $f_{cm,28}= f_{ck,cyl}+8000= 43\,000$ kN/m^2

Proračunska čvrstoća betona pri pritisku
Design concrete strength $f_{cd}= \alpha_{cc} \times f_{ck,\,cyl} / \gamma_c = 0.85 \times 35\,000 / 1.5 = 19\,834$ kN/m^2
Donja karakteristična čvrstoća betona na zatezanje (5% fraktil)
Lower characteristic concrete tensile strength (5% fractil) $f_{ctk,0.05}= 2\,200$ kN/m^2

Gornja karakteristična čvrstoća pri zatezanju (95% fraktil)
Upper characteristic concrete tensile strength (95% fractile) $f_{ctk,0.95}= 4\,200$ kN/m^2
Srednja čvrstoća na zatezanje

Average concrete tensile strength f_{ctm}= 3 200 kN/m^2

Srednja vrednost modula elastičnosti betona
Average modulus of elasticity of concrete E_{cm}= 34 000 000 kN/m^2

Ograničenje napona pritiska u betonu prema EN 1992 za mostove (granično stanje upotrebljivosti) / Concrete compressive stress limits in accordance with EN 1992 for bridges (service limit state)

Ograničenje napona pritiska u betonu radi izbegavanja pojave podužnih prslina i mikroprslina:
Concrete compressive stress limits to avoid longitudinal cracks and microcracks

- **za karakterističnu (retku) kombinaciju opterećenja**
  characteristic load combination $0.6xf_{ck,cyl}$= 0.60 x 35MPa = 21.0 MPa
- **pri nanošenju sile prednaprezanja (pre gubitaka) (SRPS EN 1992-1-1 NA 2.40)**
  at the time of prestressing (before losses) 0.7 x (0.75 x $f_{c,cyl}$)=0.70x(0.75x35) = 18.375 MPa

Ograničenje (stalnog) napona pritiska u betonu radi izbegavanja nelinearne analize tečenja betona / Concrete (permanent) compressive stress limits to avoid nonlinear concrete creep analysis

- **za kvazi-stalnu kombinaciju opterećenja**
  quasi-permanent load combination $0{,}45xf_{ck,\ cyl}$= 0,45 x 35 000 = 15 750kN/m^2

Ograničenje napona zatezanja u betonu prema EN 1992/ Concrete tensile stress limits in accordance with EN 1992:

- **za karakterističnu (retku) kombinaciju opterećenja**
  characteristic load combination f_{ctm}= 3 200 kN/m^2

Челик за преднапрезање / Prestressing steel EN 10138

- **Користи се уже са седам жица Y1860S7 /** 7-wire strands Y1860S7 are used in post-tensioning ducts

Пречник ужета / Strand diameter	15.7mm
Површина попречног пресека ужета / Strand cross-sectional area	150mm^2
Затезна чврстоћа / Tensile strength	1860 MPa
Маса по дужном метру / Mass per linear meter of 7-wire strand	1,180 kg/m
Карактеристична вредност максималне силе / Characteristic value of maximum force	259 kN
Максимална вредност максималне силе / Maximum value of maximum force	298 kN
Карактеристична вредност 0.1% доказне силе / Characteristic value of 0.1%-proof force	223 kN
Модул еластичности / Modulus of elasticity	195 GPa

- **Највећа сила затезања у ужету током преднапрезања (пре тренутних губитака и пре губитака који зависе од времена) /** Maximum tensile force in the strand during prestressing (prior to instantaneous and long-term losses)

P_{max}=Ap × min(k_1×f_{pk}; k_2×$f_{p0.1k}$)=150mm^2 ×min(0.80×1860; 0.90×1670)=min(223kN;225kN) = 223 kN

- **Почетна сила преднапрезања у ужету (после тренутних губитака, а пре губитака који зависе од времена) /** Initial prestressing force in the strand (after instantaneous and before long-term losses):

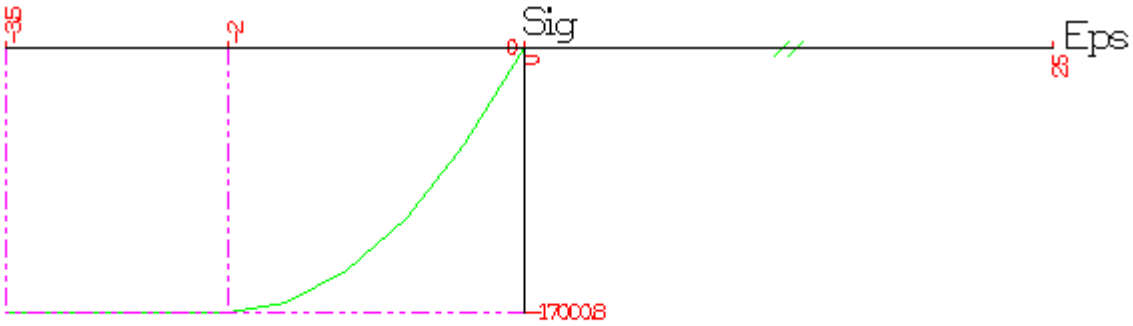
  $P_{m0} \leq Ap \times \min(k_7 \times f_{pk}; k_8 \times f_{p0.1k}) = 150mm^2 \times \min(0.75 \times 1860; 0.85 \times 1670) = \min(209; 213) = 209$ kN

- **Ограничење напона у ужету за карактеристичну комбинацију оптерећења (гранична стања употребљивости) са силом преднапрезања након свих губитака**/ Prestressing steel stress limits for characteristic load combination (service limit state) with prestressing force after all losses

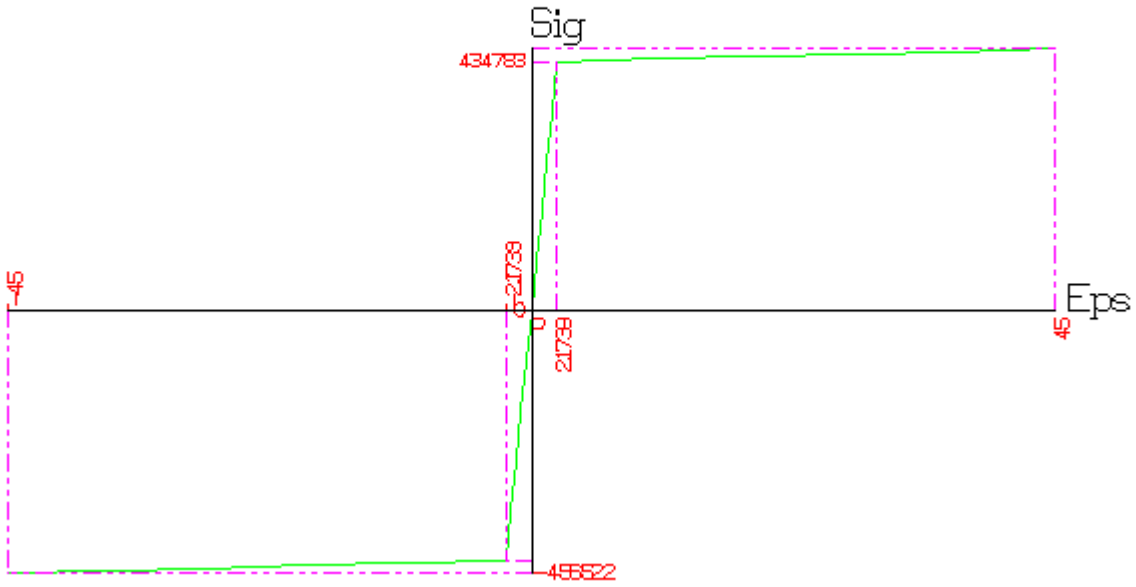
  $k_5 \times f_{pk} = 0.75 \times f_{yk} = 1252$ MPa

Material Ultimate diagram
ENEurocode:C35/45

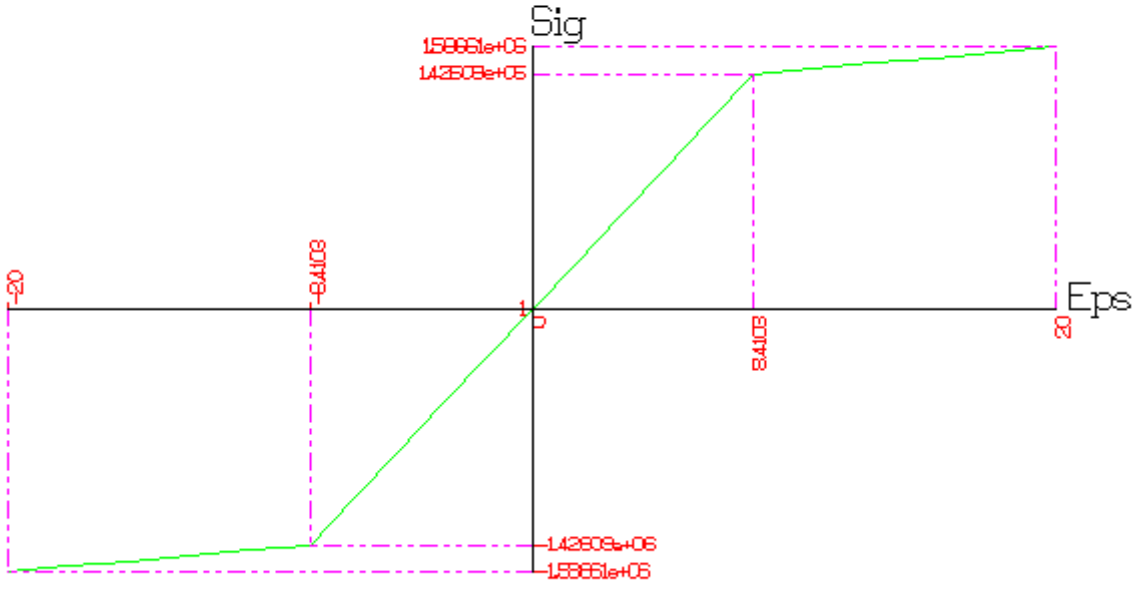
Material Ultimate diagram
ENEurocode:C30/37



Material Ultimate diagram
ENEurocode:St500(B)



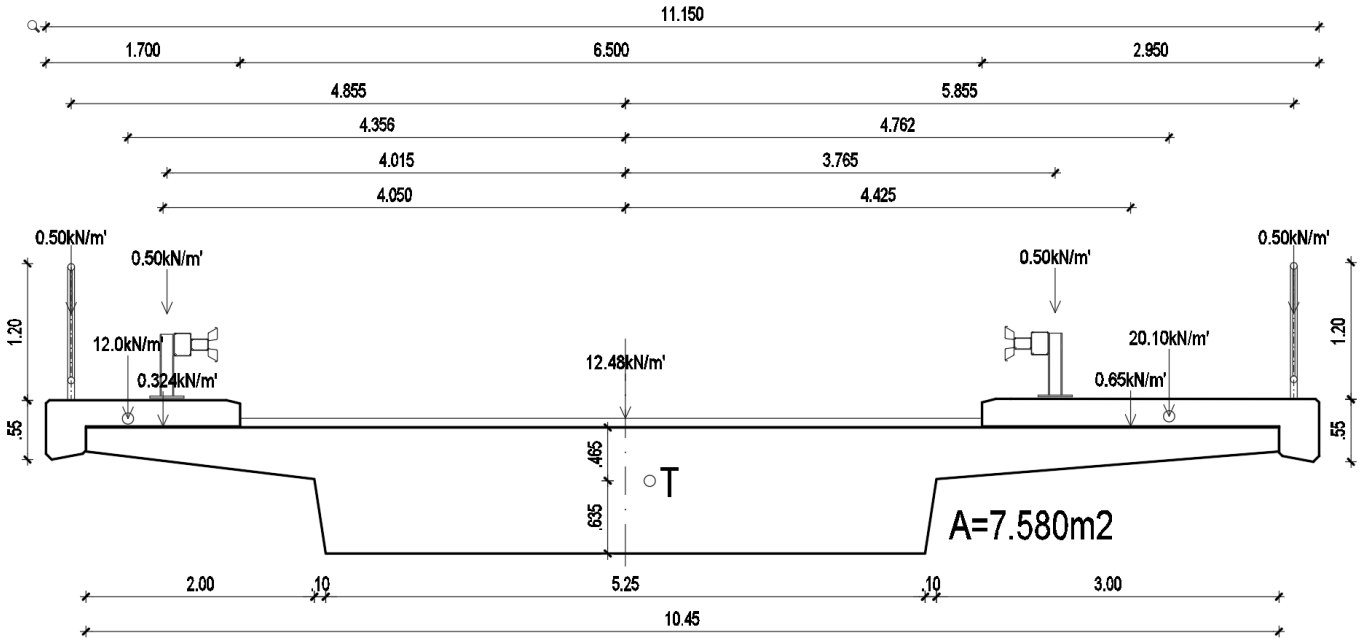
Material Ultimate diagram
ENEurocode:Strand-1640/1860



3. АНАЛИЗА ОПТЕРЕЋЕЊА

LOAD ANALYSIS

3. ANALIZA OPTEREĆENJA / LOAD ANALYSIS



3.1. СТАЛНА ОПТЕРЕЋЕЊА / DEAD LOADS

3.1.1. СОПСТВЕНА ТЕЖИНА / SELF-WEIGHT G1

Сопствена тежина преднапрегнутих греда и коловозне плоче аутоматски су узете у обзир у програмском пакету. / The self-weight of the post-tensioned, precast beams and deck are automatically taken into account by the design software.

3.1.2. ДОДАТНИ СТАЛНИ ТЕРЕТ / SUPERIMPOSED DEAD LOAD

Карактеристична вредност / Characteristic value

Асфалт / Asphalt 0.07 x 24.00 = 1.68 kN/m^2
Хидроизолација / Waterproofing 0.01 x 24.00 = 0.24 kN/m^2
Укупно / Total *1.92 kN/m^2*
1.68*6.5+0.24*10.45=**13.45 kN/m**

Пешачке стазе / Sidewalks: A1 = 0.48 m^2 A2 = 0.804 m^2
q1 = 0.480x25=**12.0 kN/m** e = -4.356 m
q2 = 0.804x25=**20.1 kN/m** e = +4.762 m
Ограда 1 / Barrier 1: q = **0.5 kN/m** e = -4.05 m
Ограда 1 / Barrier 2: q = **0.5 kN/m** e = +3.765 m
Пешачка ограда 1/ Pedestrian fence 1: q = **0.5 kN/m** e = -4.855 m
Пешачка ограда 2/ Pedestrian fence 2: q = **0.5 kN/m** e = +5.855 m

q= 13.45+12+20.1+4*0.5=47.55 kN/m

Увећана вредност / Maximum multiplier value

Асфалт / Asphalt 0.07 x 24.00 = 1.68 kN/m^2
Хидроизолација / Waterproofing 0.01 x 24.00 = 0.24 kN/m^2
Укупно / Total *1.92 kN/m^2*
1.40*1.68*6.5+1.20*0.24*10.45=**18.30 kN/m**

Пешачке стазе / Sidewalks: A1 = 0.48 m^2 A2 = 0.804 m^2
q1 = 0.480x25=**12.0 kN/m** e = -4.356 m
q2 = 0.804x25=**20.1 kN/m** e = +4.762 m
Ограда 1 / Barrier 1: q = **0.5 kN/m** e = -4.05 m
Ограда 1 / Barrier 2: q = **0.5 kN/m** e = +3.765 m
Пешачка ограда 1/ Pedestrian fence 1: q = **0.5 kN/m** e = -4.855 m
Пешачка ограда 2/ Pedestrian fence 2: q = **0.5 kN/m** e = +5.855 m

q= 18.30+12+20.1+4*0.5=52.40 kN/m

Умањена вредност / Maximum multiplier value

Асфалт / Asphalt 0.07 x 24.00 = 1.68 kN/m^2
Хидроизолација / Waterproofing 0.01 x 24.00 = 0.24 kN/m^2
Укупно / Total *1.92 kN/m^2*
0.80*1.68*6.5+0.80*0.24*10.45=**10.74 kN/m**

Пешачке стазе / Sidewalks: A1 = 0.48 m^2 A2 = 0.804 m^2
q1 = 0.480x25=**12.0 kN/m** e = -4.356 m
q2 = 0.804x25=**20.1 kN/m** e = +4.762 m
Ограда 1 / Barrier 1: q = **0.5 kN/m** e = -4.05 m
Ограда 1 / Barrier 2: q = **0.5 kN/m** e = +3.765 m
Пешачка ограда 1/ Pedestrian fence 1: q = **0.5 kN/m** e = -4.855 m
Пешачка ограда 2/ Pedestrian fence 2: q = **0.5 kN/m** e = +5.855 m

q= 10.74+12+20.1+4*0.5=44.84 kN/m

Zbog male razlike računaće se sa karalterističnom vrednošću / Due to the small difference, the characteristic value will be taken into account

Ексцентрицитет је у односу на центар коловозне плоче / Eccentricity is with respect to deck centerline

3.1.3. **СКУПЉАЊЕ И ТЕЧЕЊЕ БЕТОНА** / CREEP AND SHRINKAGE OF CONCRETE

Влажност средине / Relative humidity: 70%

Прорачун модела од реолошких утицаја (EN 1992-2) је урађен у програмском пакету и приказан је у припадајућем случају оптерећења. / The calculation of creep and shrinkage (EN 1992-2) is automatically calculated by the structural engineering software package, and sorted into its respective load case.

3.1.4. **ПРЕДНАПРЕЗАЊЕ** / PRESTRESSING

Површина попречног пресека једног кабла / Cable cross-sectional area 19 x 150mm^2 = 2850 mm^2

Количина кабла / Number of ducts

L = 126.86 m → n = 10

3.2. **ПРОМЕНЉИВА ОПТЕРЕЋЕЊА** / LIVE LOADS

3.2.1. **САОБРАЋАЈНА ОПТЕРЕЋЕЊА** / TRAFFIC LOADS

3.2.1.1. **ПОДЕЛА КОЛОВОЗА НА ПРОРАЧУНСКЕ ВОЗНЕ ТРАКЕ** / NUMBER OF NOTIONAL LANES

Ширина коловоза / Carriageway width: 6.50 m
Саобраћајне траке /Traffic lanes: w=Int(7.00/3) → 3,00+3,00+0,50 m
Број прорачунских возних трака / Number of notional lanes 2

3.2.1.2. **ГЛАВНИ МОДЕЛ ОПТЕРЕЋЕЊА (LM1)** / LOAD MODEL 1 (LM1)

Двоосовински тандем систем (TS) концентрисаних сила и једнакоподељено површинско оптерећење (UDL) / Tandem system (including two axles) (TS) and uniformly distributed load (UDL)

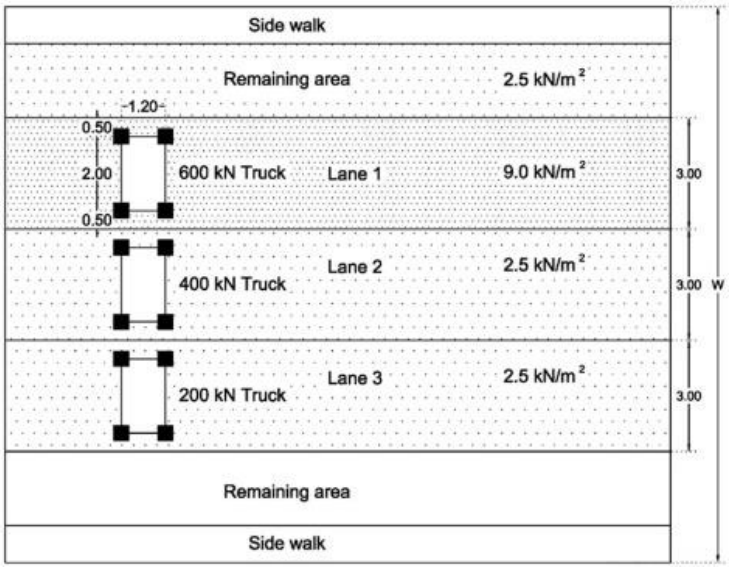
Прва трака / First lane Q_{1k} = 0.80 x 2 x 300 kN = 480 kN q_{1k}= 0.80*9.00 kN/m^2 = 7.20 kN/m^2

Друга трака / Second lane Q_{2k} = 0.80 x 2 x 200 kN = 320 kN q_{2k}= 1.0*2.50 kN/m^2 = 2.50 kN/m^2

Преостала површина / Remaining area q_{rk}= 0.5 *2.50 kN/m^2= 1.25 kN/m^2

Сервисна стаза (ширина 0.75 m) / Sidewalk (0,75 m-wide) 3.00 kN/m^2

Пешачка стаза (ширина 2.0 m) / Walkway (2,0 m-wide) 3.00 kN/m^2

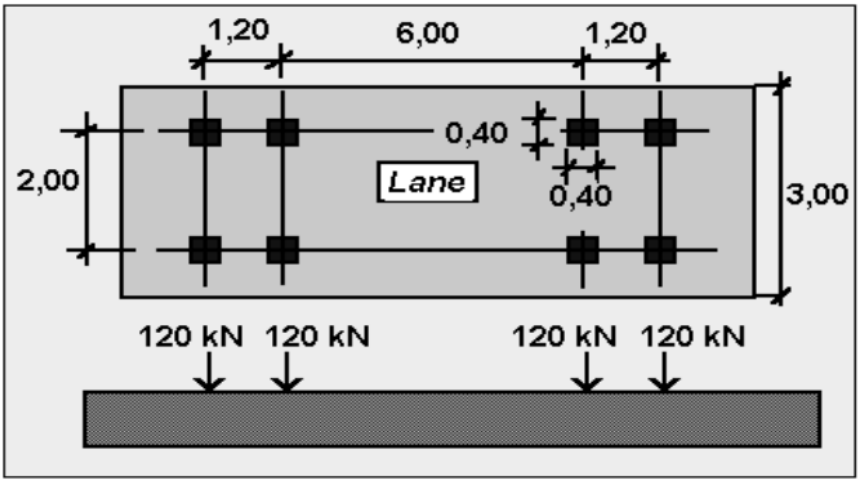


***Šema modela opterećenja 1**/ Scheme of LM1*

Двоосовински тандем систем (TS) концентрисаних сила поставља се у свакој саобраћајној траци у комбинацији са једнакоподељеним површинским оптерећењем (UDL).

A double-axle load Tandem System (TS) is applied in each traffic lane in conjunction with a uniformly distributed load system (UDL).

3.2.1.3. **МОДЕЛ ЗАМОР ОПТЕРЕЋЕЊА 3 (FLM3)** / FATIGUE LOAD MODEL (FLM3)



Срачунава се опсег напона (алгебарска разлика између минималног и максималног напона) у елементу конструкције проузрокована проласком FLM 3. Тај опсег се онда користи да се срачуна еквивалентни опсег напона, пратећи Еврокод 2 Део 2 Анекс НН.2 / Stress range (algebraic difference between maximum and minimum stress) in the element of the structure caused by FLM3 crossing the bridge is calculated. Equivalent stress ranges are calculated following Eurocode 2 Part 2 Anex NN2.

Где је потребно, два FLM3 возила се постављају у исту траку, узимајући у обзир следеће услове:

1. **Друго возило је исте конфигурације као и прво, с тим да је тежина осовине другог возила 36 kN (а не 120 kN)**
2. **Раздаљина између два возила (мерена од центра једног возила до центра другог возила) није мања од 40м.**

Two vehicles in the same lane should also be considered, with the following conditions:

Second vehicle has the same geometry as the first vehicle, but with an axle load of 36 kN, and not 120kN.

1. Distance between vehicles (measured from the center of the first vehicle to the center of the second vehicle) is not less than 40m.

- **Модели оптерећења (на замор) 1 и 2 су предвиђени за неограничени животни век услед замора и генерално се не користе (јер су превисе на страни сигурности) /** Fatigue load models 1 and 2 have been developed for infinite fatigue life and are generally not used (they are overly conservative)
- **Модели оптерећења (на замор) 4 и 5 су предвидјени за детаљнију анализу и одредјивање спектра замора (засновану на Палмгерн-Минер Закону) и нису коришћени у овом случају (није предвидјена њихова употреба по Еврокоду за овај тип конструкције) /** Fatigue load models 4 and 5 have been developed for refined analysis (based on Palmgern-Miner's Law) and are not used in this case (their use is not intended by Eurocode for these types of structure)

3.2.1.4. **СИЛЕ ПОКРЕТАЊА И КОЧЕЊА ВОЗИЛА** / ACCELERATION AND BRAKING FORCE OF VEHICLES

$180kN \cdot \alpha_{Q1} \leq Q_{lk} = 0.60 \cdot \alpha_{Q1} \cdot (2 \cdot Q_{1k}) + 0.10\, \alpha_{q1} \cdot q_{1k} \cdot wl \cdot L \leq 900\ kN$

α_{Q1}= 0.8 Q_{1k}= 300 kN
α_{q1}= 0.8 q_{1k}= 9,00 kN/m2
w_l=3.00m L1=127 m , L2=36.5 m

Q_{lk}= 0.60·0.8·(2·300)+0.1·0.8·9.00·3.00·127= 562 kN
Q_{lk}= 0.60·0.8·(2·300)+0.1·0.8·9.00·3.00·36,5= 367 kN

Усвојена вредност силе / Force to be resisted:

±562 kN (562/127 = 4.43 kN/m')
±367 kN (367/36,5 = 10,05 kN/m')

3.2.1.5. **ОПТЕРЕЋЕЊЕ НА ПЕШАЧКИМ СТАЗАМА** / PEDESTRIAN LOAD ON FOOTWAY

Карактеристично оптерећење на пешачким стазама

Characteristic pedestrian load on sidewalks

q_{fk} = 5 kPa

За прорачуне локалних елемената, потребно је анализирати и карактеристичну вредност концентрисане силе Q_{fwk} која делује на површини 10цм x 10цм на пешачкој стази

For local effects, characteristic value of concentrated load Q_{fwk}, acting on a 10 cm^2 surface on footway should also be considered.

Q_{fwk} = 10 kN

3.2.2. **УТИЦАЈИ ОД ТЕМПЕРАТУРЕ** / TEMPERATURE LOADS

ТЕМПЕРАТУРНИ УТИЦАЈИ НА ГЛАВНОМ НОСАЧУ / TEMPERATURE, SUPERSTRUCTURE
Дебљина коловоза / Surfacing (asphalt and waterproofing) thickness: 80mm

Равномерна температурна промена / Uniform temperature change

Почетна температура при којој је конструкција моста комплетирана, односно постављена на лежишта / Temperature at the end of construction (when superstructure is set on bearings)
$T_0 = 10^0$ C
Најмања и највећа температура ваздуха (Нови Сад–Суботица) /Maximum and minimum air temperature (Novi Sad–Subotica)
$T_{max} = 42^0$C
$T_{min} = -29^0$C
Најмања и највећа температура надконструкције / Maximum and minimum superstructure temperature:
$T_{e,max} = T_{max} + 2 = 44^0$C
$T_{e,min} = T_{min} + 8 = -21^0$C
Максимална негативна рачунска температура / Maximum contraction range of the uniform temperature change
$\Delta T_{N,con} = T_0 - T_{e,min} = 10+21 = -31^0$C
Максимална позитивна рачунска температура / Maximum expansion range of the uniform temperature change
$\Delta T_{N,exp} = T_{e,max} - T_0 = 44-10 = +34^0$C
Прорачун лежишта и дилатација / Design of expansion joints and bearings:
$\Delta T_{N,neg} = \Delta T_{N,com} - 20 = -31-20 = -51^0$C
$\Delta T_{N,pos} = \Delta T_{N,max} + 20 = 34+20 = +54^0$C

Линеарна промена температуре / temperature gradient **:**

Карактеристична вредност линеарне промене температуре (Еврокод Приступ 1) / Characteristic temperature gradient (Eurocode Approach 1):
$\Delta T_{M,heat} = 15^o$
$\Delta T_{M,cool} = 8^o$
Фактор утицаја дебљине коловоза / Surfacing thickness factor
$k_{sur} = 0.82$ – **Горња страна топлија** / Top surface warmer
$k_{sur} = 1.0$ – **Доња страна топлија** / Bottom surface warmer

Линеарно променљива температура / Temperature gradient
Горња страна / Top surface $\Delta T_{M,heat} = 15^o \times 0.82 = 12.3^0$C
Доња страна / Bottom surface $\Delta T_{M,cool} = 8^o \times 1.0 = 8^0$C

Комбинација равномерне температурне промене и линеарне промене температуре / Combinations of uniform temperature change and temperature gradient

$\omega_N = 0.35$ $\omega_M = 0.75$
$\Delta T_{N,exp} = +44^0$ $\Delta T_{M,heat} = 12.3^0$

$\Delta T_{N,con} = -21^0$ $\Delta T_{M,cool} = 8^0$

Усваја се неповољнија комбинација / The following combinations are considered:

$\Delta T_{M,heat}$ (ili/or $\Delta T_{M,cool}$) + ω_N* $\Delta T_{N,exp}$ (ili/or $\Delta T_{N,con}$)
ω_M *$\Delta T_{M,heat}$ (ili/or $\Delta T_{M,cool}$) + $\Delta T_{N,exp}$ (ili/or $\Delta T_{N,con}$)

ТЕМПЕРАТУРНИ УТИЦАЈИ НА СТУБОВИМА / TEMPERATURE LOADS IN PIERS
Линеарна промена температуре / Temperature gradient: $\Delta_t = 5^0$

3.2.3. **ОПТЕРЕЋЕЊЕ ВЕТРОМ /** WIND LOADS (w)

Утицај ветра на суперструктуру / Wind loads on superstructure

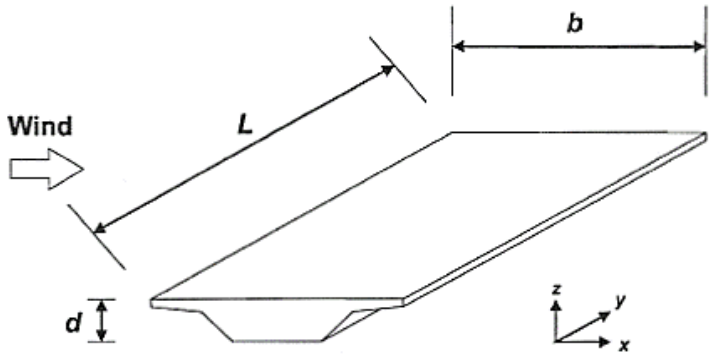


Figure 8.2 — Directions of wind actions on bridges

Висина објекта изнад терена / Bridge height above ground h = 9.70 m

Ширина објекта / Bridge width b = 9.40 m

Висина надконструкције / Superstructure height d = 1.10 m

Дужина моста припадајућа једном стубу / Tributary length for one pier 23.20 m

Локација/Location: Novi Sad – Subotica

Фундамнетална основна брзина ветра /

Fundamental basic wind velocity v_{b0}= 20 m/s (Novi Sad 21m/s, Subotica 19 m/s)

Фактор оптерецења ветром (EC 1991-1-4, Wind load factor C (EC 8.3.2, Table 8.2)

$C = c_e \times c_f = 2.329 \times 1.3 = 3,0277$

- **Оптерећење у x правцу**

Fundamentnalna osnovna brzina vetra / Fundamental basic wind velocity $v_{bo} := 20 \cdot \frac{m}{s}$ Vojvodina

Koeficijent pravca delovanja vetra / Directional factor $C_{dir} := 1.0$

Koeficijent sezonskog delovanja / Seasonal factor $C_{seas} := 1.0$

Osnovna brzina vetra / Basic wind velocity $v_b := C_{dir} \cdot C_{seas} \cdot v_{bo} = 20 \frac{m}{s}$

Gustina vazduha / Air density $\rho := 1.25 \frac{kg}{m^3}$

Druga kategorija terena je usvojena. / Second terrain category is assumed.

Parametri hrapavosti terena / Roughness parameters $z_o := 0.05m$ $z_{min} := 2m$ $k_r := 0.19$

Referentna visina / Reference height $z := 9.7m$

Koeficijent hrapavosti terena / Roughness coefficient $c_r := k_r \cdot \ln\left(\frac{z}{z_o}\right) = 1$

Koeficijent topografije terena / Orography coefficient $c_o := 1$

Srednja (proseč na) brzina vetra / Mean wind velocity $v_m := c_r \cdot c_o \cdot v_b = 20 \frac{m}{s}$

Koeficijent turbulencije / Turbulence factor $k_l := 1$

Intenzitet turbulencije / Turbulence intensity $I_v := \frac{k_l}{c_o \cdot \ln\left(\frac{z}{z_o}\right)} = 0.19$

Koeficijent izlož enosti / Exposure factor $c_e := 1 + 7 \cdot I_v = 2.329$

Koeficijent sile / Force coefficient $c_f := 1.3$

Koeficijent konstrukcije kojim se uzima u obzir njen dinamicki odgovor / Dynamic response coefficient $c_s := 1$ $c_d := 1$

Dubina superstrukture za referentnu povrsinu (most opterecen saobracajem) / Superstructure depth for reference area (bridge loaded with traffic) $d_{tot\_tr} := 1.1m + 2m = 3.1\,m$

Dubina superstrukture za referentnu povrsinu (most neopterecen saobracajem) / Superstructure depth for reference area (bridge not loaded with traffic) $d_{tot} := 1.1m + 3 \cdot 0.3m = 2\,m$

Linijsko opterec enje vetrom (most opterec en sa saobracajem) / Line wind load (wind loaded with traffic) $f_{w\_z} := c_s \cdot c_d \cdot c_e \cdot \frac{1}{2} \cdot \rho \cdot v_m^{\,2} \cdot c_f \cdot d_{tot\_tr} = 2.35 \cdot \frac{kN}{m}$

Linijsko opterec enje vetrom (most neopterec en sa saobracajem) / Line wind load (wind loaded with traffic) $f_{w\_} := c_s \cdot c_d \cdot c_e \cdot \frac{1}{2} \cdot \rho \cdot v_m^{\,2} \cdot c_f \cdot d_{tot} = 1.52 \cdot \frac{kN}{m}$

- **Оптерећење ветром у y је занемарено.**
- **Оптерећење у Z правцу**

Као сто је поменуто у Еврокоду Део 1.4 8.3.3 Примедба 2, сила ветра у z правцу мозе да има значајан ефекат само ако је истог реда величине као и стално оптерећење. С обзиром да је ова сила доста мања од сталног оптерећења, неце се даље разматрати у анализи. / As noted in Eurocode Part 1.4 8.3.3 Note 2, the wind force in the Z direction may have significant effects provided that the force is of the same order of magnitude as the dead load. In the case of these particular bridges, this force is significantly smaller than the dead load, and as such is discarded from further analysis.

3.2.4. **ЗАМЕНА ЛЕЖИШТА /** REPLACEMENT OF BEARINGS

Δ_s =+1,00 cm **на svakom stubu sa ležištima** / at every support with bearings

3.2.5. **СЛЕГАЊЕ ОСЛОНАЦА /** SETTLEMENT

Δ_s =-1,00 cm

3.3. ИНЦИДЕНТНА ОПТЕРЕЋЕЊА / INCIDENTAL LOADS

3.3.1. СЕИЗМИЧКИ УТИЦАЈИ / EARTHQUAKE LOADS

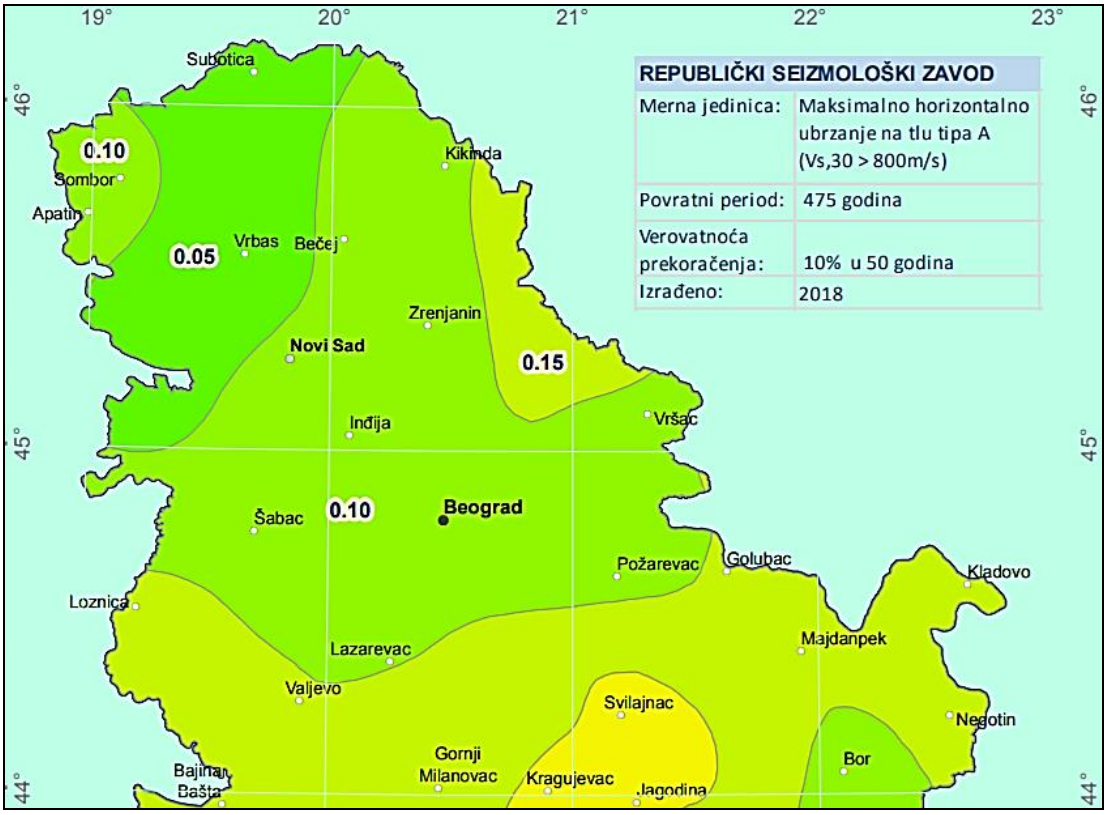
Метода анализе: Метода фундаменталног тона (EN 1998 Део 2). /
Method of analysis: Fundamental Mode Method (EN 1998 Part 2).

Локација / Location: Novi Sad – Subotica, Serbia

Фактор значаја моста /Importance factor: γ_i=1,0

Рачунско убрзање тла (очитано са мапе за тип тла А, касније се модификује за усвојени тип тла) / Design ground acceleration (read from the map for ground type A, and subsequently modified for the given soil type):

$a_g = \gamma_i \times a_{gr}$=0.05g (**повратни период 475** / return period of 475 years)



Tip tla / Soil type:

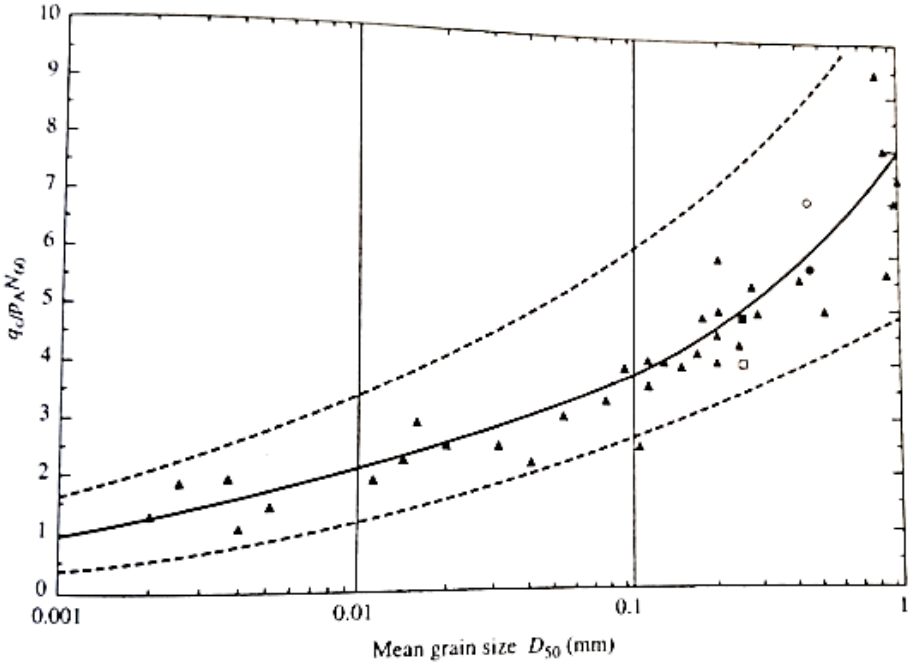


Figure 7-38
Correlation between CPT cone resistance and SPT blow count. *(Robertson et al. 1983; with permission from ASCE)*

Усвојен тип тла С према EN 1998-1 / Soil type C is used (EN 1998-1)

Проценат вискозног пригушења / Viscous damping ratio: ξ=5%

Фактор пригушења / Damping factor: η=1,00

Фактор понашања / Behaviour factor:

q=1,00

Рачунске сеизмичке силе према EC8/1 / Earthquake design loads according to EC8 /1

$E_x + 0{,}3E_y + 0{,}3E_z$
$0{,}3E_x + E_y + 0{,}3E_z$
$0{,}3E_x + 0{,}3E_y + E_z$

Једначине пројектног спектра одговора за еластичну анализу
Equations for design spectrum, following an elastic analysis
Пројектни спектар за хоризонталне компоненте
Design spectrum for horizontal components

$0 \le T \le T_B: \; S_d(T) = a_g \cdot S \cdot \left[\frac{2}{3} + \frac{T}{T_B}\left(\frac{2.5}{q} - \frac{2}{3}\right)\right]$

$T_B \le T \le T_C: \; S_d(T) = a_g \cdot S \cdot \frac{2.5}{q}$

$T_C \le T \le T_D: \; S_d(T) \begin{cases} = a_g \cdot S \cdot \frac{2.5}{q} \cdot \left[\frac{T_c}{T}\right] \\ \ge \beta \cdot a_g \end{cases}$

$T_D \le T: \; S_d(T) \begin{cases} = a_g \cdot S \cdot \frac{2.5}{q} \cdot \left[\frac{T_c \cdot T_d}{T^2}\right] \\ \ge \beta \cdot a_g \end{cases}$

β=0,2

- **Вредности параметара који дефинишу Еластични спектар одговора**

  Parameters describing the elastic response spectrum

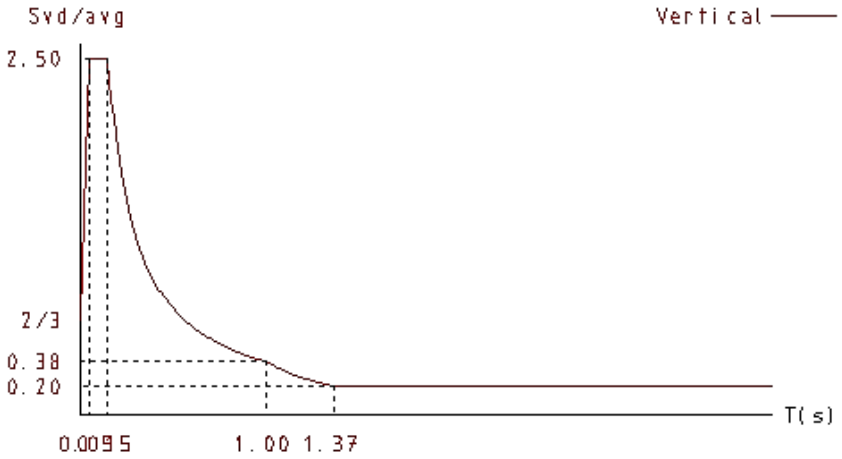
Tip tla	S	T_B(s)	T_C(s)	T_D(s)
A	1	0.15	0.4	2
B	1.2	0.15	0.5	2
C	1.15	0.2	0.6	2
D	1.35	0.2	0.8	2
E	1.4	0.15	0.5	2

- **Вредности параметара који дефинишу Вертикални еластични спектар одговора**

  Parametars describing the vertical elastic response spectrum

Spektar	a_{vg}/a_g	T_B(s)	T_C(s)	T_D(s)
Tip 1	0.9	0.05	0.15	1.0

За пројектни спектар / For design spectrum q=1,0



6 КОМБИНАЦИЈЕ ОПТЕРЕЋЕЊА ПРЕМА ЕС / LOAD COMBINATIONS IN ACCORDANCE WITH EC

Комбинације за гранично стање употребљивости / Combinations at the serviceability limit state, SLS

Карактеристичне комбинације оптерећења / Characteristic load combinations

$$\sum_{j\geq 1}\left(G_{kj,sup}+G_{kj,inf}\right)+P_K+\begin{cases}(TS+UDL+q_{fk}^{*})+0.6*F_{wk,traffic}\\ gri_{i=1b,2,3,6}+0.6*T_k\\ gr1b\\ T_K+(0.75*TS+0.4*UDL+0.4*q_{fk}^{*})\\ F_{Wk}\end{cases}$$

Честе комбинације оптерећења / Frequent load combinations

$$\sum_{j\geq 1}\left(G_{kj,sup}+G_{kj,inf}\right)+P_K+\begin{cases}(0.75*TS+0.4*UDL)+0.5*T_K\\ 0.75*gr1b\\ 0.6*T_K\\ 0.2*F_{Wk}\end{cases}$$

Квази-перманентне комбинације оптерећења / Quasi-permanent load combinations

$$\sum_{j\geq 1}\left(G_{kj,sup}+G_{kj,inf}\right)+P_K+0.5*T_K$$

Комбинације за гранично стање носивости / Combinations at the ultimate limit state, ULS

Сталне прорачунске ситуације / Persistent design situations

$$\sum_{j\geq 1}\left(1.35*G_{kj,sup}+1.00*G_{kj,inf}\right)+\gamma_P*P_K+\begin{cases}1.35*(TS+UDL+q_{fk}^{*})+1.5*0.6*F_{wk,traffic}\\ 1.35*gri_{i=1b,2,3,6}\\ 1.5*T_K+1.35*(0.75*TS+0.4*UDL+0.4*q_{fk}^{*})\\ 1.5*F_{Wk}\end{cases}$$

- $G_{kj,sup}$ – **карактеристичне вредности сталних дејстава (неповољно дејство)** / characteristic dead load (unfavourable action)
- $G_{kj,inf}$ – **карактеристичне вредности сталних дејстава (повољно дејство)** / characteristic dead load (favourable action)
- γ_P – 1.0; P_k – **репрезентативна (средња) вредност дејства услед преднапрезања** / representative (mean) prestressing force
- TS – **Двоосовински тандем систем концентрисаних саобраћајних сила** / Tandem system traffic load
- UDL – **Једнакоподељено површинско саобраћајно оптерећење** / Uniformly distributed traffic load
- q_{fk}* – **оптерећење за комбиновање пешачких стаза** / combination value of vertical loads on sidewalks
- $F_{wk,traffic}$ – **оптерећење ветром када је присутно и саобраћајно оптерећење на мосту /** wind loads taking into consideration the presence of road traffic
- gri_i – **групе саобраћајних оптерећења /** traffic load groups
- T_k – **карактеристична вредност температурног оптерећења /** characteristic value of wind load
- F_{wk} – **карактеристична вредност оптерећења ветром /** characteristic value of wind load

		Коловоз						Пешачке и бицикл. стазе
Тип оптерећења		Вертикалне силе				Хоризонталне силе		Само вертикалне силе
Референца из SRPS EN 1991-2:2012		4.3.2	4.3.3	4.3.4	4.3.5	4.4.1	4.4.2	5.3.2 (1)
Систем оптерећења		LM1 (TS и UDL)	LM2 (једна осовина)	LM3 (специјална возила)	LM4 (пешачка навала)	Q_{lk} Силе кочења и покретања	Q_{tk} Центрифу–галне и по–пречне силе	
Групе оптерећења	gr1a	Карактеристи–чна вредност						3,00 kN/m^2
	gr1b		Каракт. вредност					
	gr2	Честа вредност				Каракт. вредност	Каракт. вредност	
	gr3[d]							Каракт. вредност[c]
	gr4				Каракт. вредност			Каракт. вредност
	gr5			Каракт. вредност				
	gr6[e]	0,5 × Каракт. вредност				0,5 × Каракт. вредност	0,5 × Каракт. вредност	Каракт. вредност
		Доминантно компоненто дејство.						

[c] Видети SRPS EN 1991-2:2012, тачка. 5.3.2.1(2). Разматра се само једна оптерећена пешачка стаза ако је то неповољније од обе оптерећене пешачке стазе.
[d] gr3 није релевантан, ако се разматра gr4.
[e] gr6 се примењује само за прорачунске ситуације које се односе на замене лежишта.

Grupe saobraćajnih opterećenja / *Traffic load groups*

Оптерећења LM3 и ЛМ4 нису захтевана од стране инвеститора (њихова употреба није уобицајена), па се групе оптерећење гр4 и гр5 не користе / Load models LM3 and LM4 have not been requested (these loads are not commonly used in practice); thus, load groups gr4 and gr5 have not been considered

Прорачунске ситуације за замор/ Fatigue design situations

Срачунати прорачунски опсег напона се упоредјује са номиналном носившћу на замор (за челик за армирање, за каблове за преднапрезање, и за бетон у притиску и при смицању) одредјену према Еврокод 2 Део 1.1 Члан 6.8.5. / Calculated design stress range is then compared with nominal fatigue resistance calculated according to Eurocode 2 Part 1.1 Article 6.8.5 (for reinforcement steel, prestressing steel, concrete compression and concrete shear)

Израз за проверу замора у челику за армирање и кабловима за преднапрезање / Expression for fatigue check for reinforcement and prestressed steel

$\gamma_{F,fat} * \Delta\sigma_{s,equ}(N^*) \leq (\Delta\sigma_{Rsk}(N^*)) / \gamma_{S,fat}$

Парцијални фактор за замор оптерећење (Evrokod 2 Part 1.1 - 2.4.2.3) / Partial factor for fatigue loads (Eurocode 2 Part 1.1 - 2.4.2.3)

$\gamma_{F,fat} = 1.0$

Парцијални фактор за материјале (Evrokod 2 Part 1.1 - 2.4.2.4) / Partial factor for materials (Eurocode 2 Part 1.1 - 2.4.2.4)

Бетон / Concrete $\gamma_{C,fat} = 1.5$

Челик за армирање и за преднапрезање / Reinforcement and prestressing steel $\gamma_{S,fat} = 1.15$

Инцидентне и сеизмицке прорацунске ситуације / Accidental and seismic design situations

Table A2.5 - Design values of actions for use in accidental and seismic combinations of actions

Design situation	Permanent actions		Prestress	Accidental or seismic action	Accompanying variable actions (**)	
	Unfavourable	Favourable			Main (if any)	Others
Accidental(*) (Eq. 6.11a/b)	$G_{k,j,sup}$	$G_{k,j,inf}$	P	A_d	$\psi_{1,1} Q_{k,1}$ or $\psi_{2,1} Q_{k,1}$	$\psi_{2,i}\ Q_{k,i}$
Seismic(***) (Eq. 6.12a/b)	$G_{k,j,sup}$	$G_{k,j,inf}$	P	$A_{Ed} = \gamma_I A_{Ek}$		$\psi_{2,i}\ Q_{k,i}$

(*) In the case of accidental design situations, the main variable action may be taken with its frequent or, as in seismic combinations of actions, its quasi-permanent values. The choice will be in the National Annex, depending on the accidental action under consideration.

(**) Variable actions are those considered in Tables A2.1 to A2.3.

(***) The National Annex or the individual project may specify particular seismic design situations. For railway bridges only one track need be loaded and load model SW/2 may be neglected.

NOTE The design values in this Table A2.5 may be changed in the National Annex. The recommended values are $\gamma = 1{,}0$ for all non seismic actions.

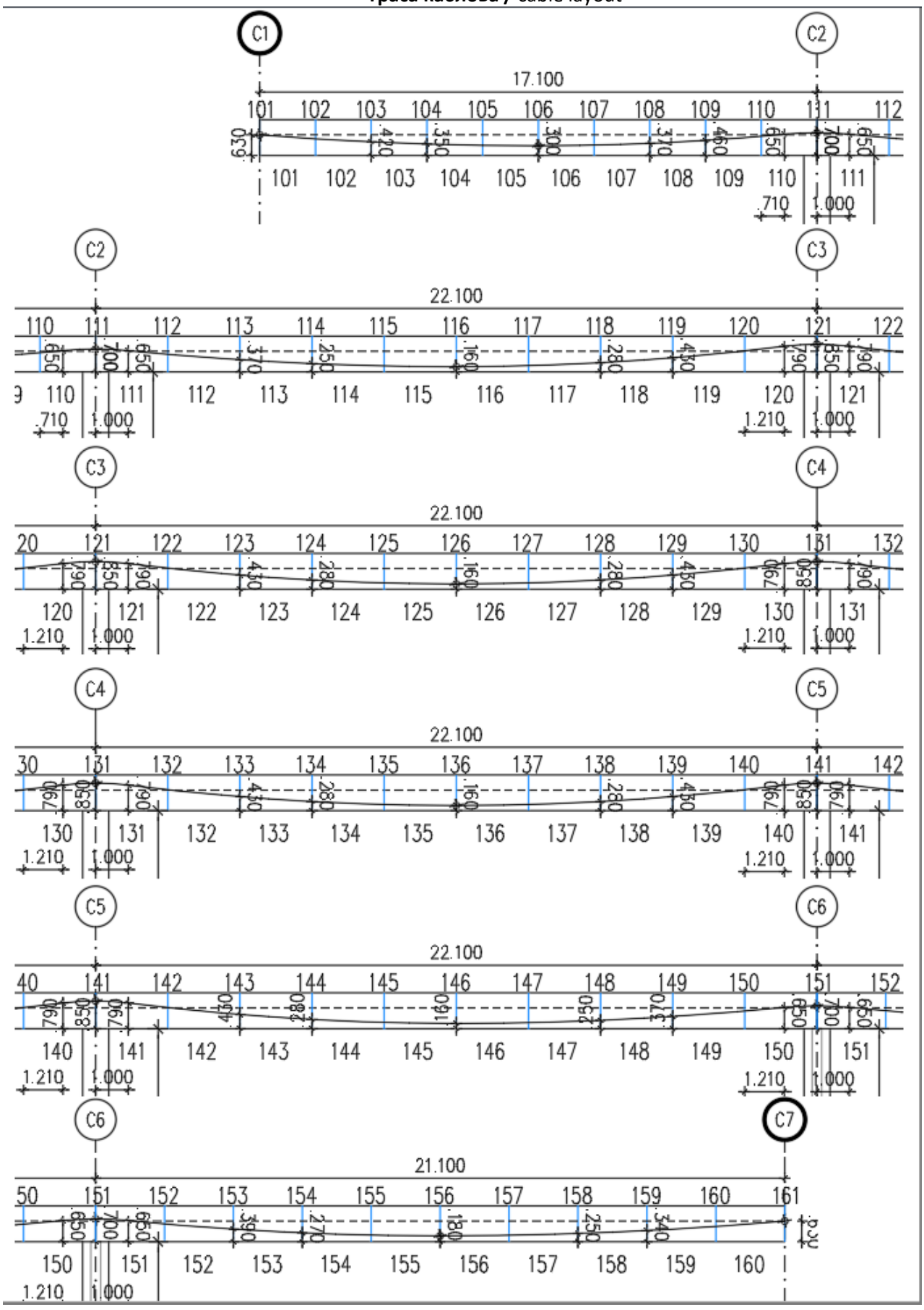
4. ИЗВЕШТАЈ СТРУКТУРАЛНЕ АНАЛИЗЕ

STRUCTURAL ANALYSIS REPORT

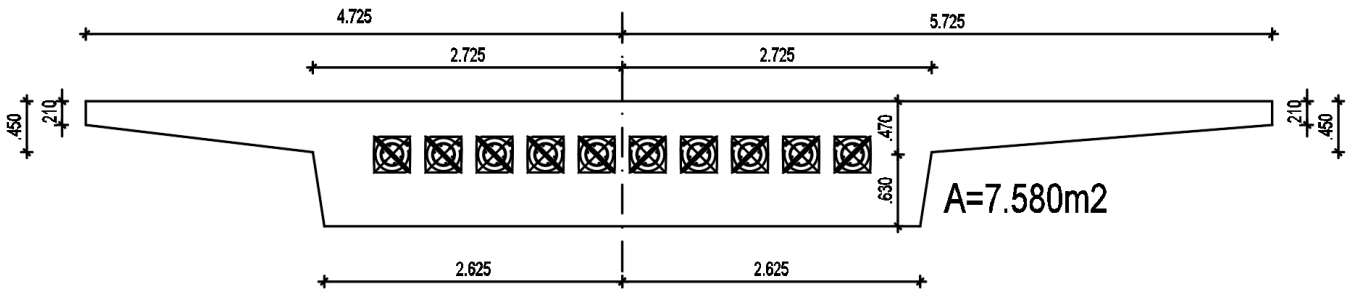
4.1. ГЕОМЕТРИЈА КАБЛОВА ЗА ПРЕДНАПРЕЗАЊЕ

PROFILE OF PRESTRESSING TENDONS

Траса каблова / cable layout



Попречни пресек / Cross section



Резултантни кабл / Resultant cable 10x19Ø15.7

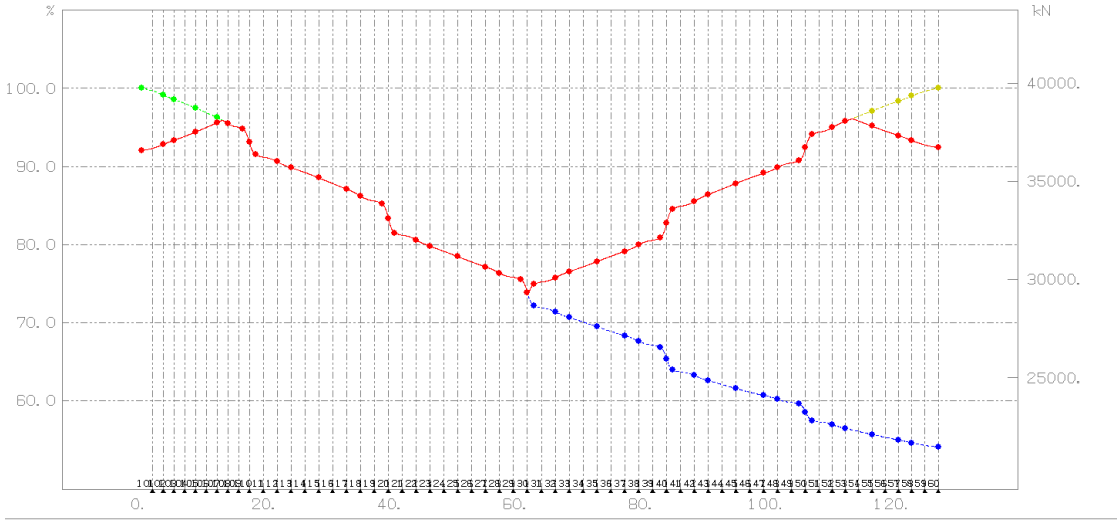
Површина попречног пресека једног кабла / Cable cross-sectional area 19 x 150mm^2 = 2850 mm^2

Количина кабла / Number of ducts L = 126.86 m → n = 10

Почетна сила по каблу / Initial prestressing force per cable N =19 x 209kN = 3971 kN

Издужење кабла/tendon elongation 67.52cm/11.69cm

Тренутни губици / Instantaneous prestress losses



Tendon pre-stressing – Normal force diagram
Tendon 101 Stress group STG1

sig allow = 0.139E+07
A = 0.0029
N_{Tendon} = 10

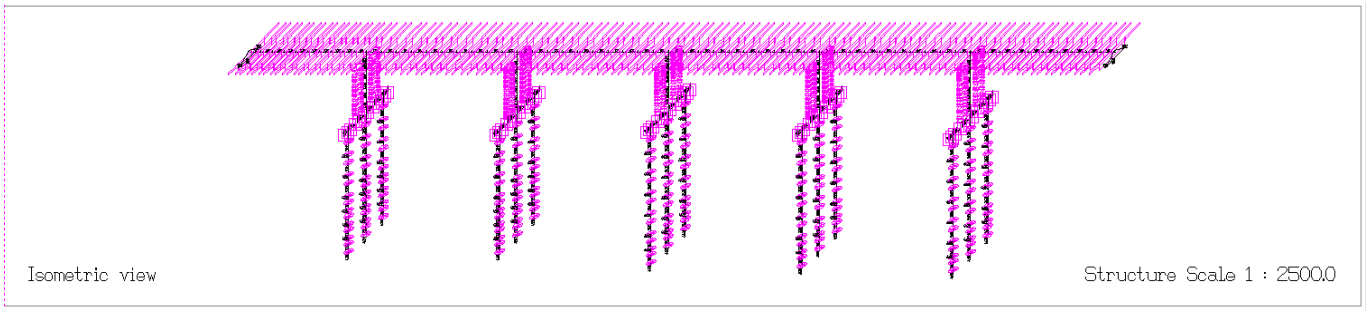
TENDON No. : 101

Number of tendons	: 10
Material	: Strand-1640/1860
Tendon nominal area	: +2.85000e-03
Tendon duct area	: +7.85000e-03
Friction (my)	: 0.22000
Wobble angle (Beta)	: 0.30000
E-Modul - static	: +1.95000e+08
E-Modul - prestress.	: +1.95000e+08
Allow. stress	: +1.39400e+06

Tendon	Action		Nb Nb%	Ne Ne%	dl	L
101	STRESS	START	3972.900 1.000	2146.775 0.540	0.67520	126.855
101	WEDGE SLIP	START	3656.256 0.920	3811.291 0.959	-0.00400	12.830
101	STRESS	END	2920.432 0.735	3972.900 1.000	0.11692	65.329
101	WEDGE SLIP	END	3819.101 0.961	3671.255 0.924	-0.00400	13.694

4.2. УЛАЗНИ ПОДАЦИ ЗА ПРОРАЧУН МОДЕЛА

STRUCTURAL ANALYSIS DATA INPUT



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1 Material properties

Material Properties	C_30/37 (used)		
Group	EN_Eurocode		
Description	C_30/37 (prEN 1992-		
Type	CONCRETE		
Modulus of elasticity	Emod	33000000	KN/M2
Poisson's ratio	ny	0.20	-
Shear-Modulus	Gmod	13750000	KN/M2
Specific weight	Gamma	25.00	KN/M3
Coeff. of thermal expansion	AlphaT	1e-5	1/CELSIUS
Coefficient of concrete consistency (1-3)	CF	2	-
Degree of cement hardening (1-3)	HCF	2	-
Water cement ratio	(WCR)	0.4	-
Cement content in concrete	(CECO)	3	-
Characteristic compressive cylinder strength of concrete at	fck	3e4	KN/M2
Characteristic cube compressive strength of concrete at 28	fck,cube	37e3	KN/M2
Mean value of concrete compressive strength	fcm	38e3	KN/M2
Mean value of axial tensile strength of concrete	fctm	2900	KN/M2
Tension split strenght	fct	2030	KN/M2
Tension bending strenght	(TSB)	0	KN/M2

Stress limits		min	max	
	1	-18000.00	2900.00	KN/M2
	2	-13500.00	2900.00	KN/M2
	3	-18000.00	0.00	KN/M2

Material Properties	C_35/45 (used)		
Group	EN_Eurocode		
Description	C_35/45 (prEN 1992-		
Type	CONCRETE		
Modulus of elasticity	Emod	34000000	KN/M2
Poisson's ratio	ny	0.20	-
Shear-Modulus	Gmod	14166670	KN/M2
Specific weight	Gamma	25.00	KN/M3
Coeff. of thermal expansion	AlphaT	1e-5	1/CELSIUS
Coefficient of concrete consistency (1-3)	CF	2	-
Degree of cement hardening (1-3)	HCF	2	-
Water cement ratio	(WCR)	0.4	-
Cement content in concrete	(CECO)	3	-
Characteristic compressive cylinder strength of concrete at	fck	35e3	KN/M2
Characteristic cube compressive strength of concrete at 28	fck,cube	45e3	KN/M2
Mean value of concrete compressive strength	fcm	43e3	KN/M2
Mean value of axial tensile strength of concrete	fctm	3200	KN/M2
Tension split strenght	fct	2240	KN/M2
Tension bending strenght	(TSB)	0	KN/M2

Stress limits		min	max	
	1	-21000.00	3200.00	KN/M2
	2	-15750.00	3200.00	KN/M2
	3	-21000.00	0.00	KN/M2

Material Properties	Strand-1640/1860 (u

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Group	Default		
Description	Strand-1640/1860 (p		
Type	PRESTRESSING		
Modulus of elasticity	Emod	195000000	KN/M2
Poisson's ratio	ny	0.30	-
Shear-Modulus	Gmod	75000000	KN/M2
Specific weight	Gamma	78.50	KN/M3
Coeff. of thermal expansion	AlphaT	1e-5	1/CELSIUS
Tensile strength of prestressing steel	fpk	186e4	KN/M2
Design tensile strength of prestressing steel	fpd	1617391	KN/M2
Modulus of elasticity of prestressing steel	Ep	195e6	KN/M2
Stressing limit	SIGP	1394e3	KN/M2
Coeff. for prestr. type (smooth or profiled)	XI	0.5	-
Relaxation class	RELCL	2	-

2 Combinations

		Combinations					
LF/SUP	Rule	(+) / (-)	(+) / (-)	(+) / (-)	(+) / (-)	(+) / (-)	(+) / (-)
		Comb 1	Comb 2	Comb 3	Comb 4	Comb 5	Comb 6
SUM-SW	SupAddLc	1.00	1.00	1.00	1.00	1.00	1.00
SUM-SDL	SupAddLc	1.00	1.00	1.00	1.00	1.00	1.00
SUM-PT	SupAddLc	1.00	0.90 / 1.10	0.90 / 1.10	0.90 / 1.10	0.90 / 1.10	0.90 / 1.10
SUM-CSt0	SupAddLc	1.00	1.00	1.00	1.00	1.00	1.00
SUM-CStinf	SupAddLc			1.00		1.00	
SUM-CStinf	SupAndLc	1.00					
LM1-TS.sup	SupAndSup	1.00	1.00	1.00	1.00	1.00	0.75
LM1-UDL.sup	SupAndSup	1.00	1.00	1.00	1.00	1.00	0.40
Pedestrian.su	SupAndSup				1.00	1.00	0.40
Brake.sup	SupAndSup						
WindS+T.sup	SupAndSup	0.60	0.60	0.60			
Temp.sup	SupAndSup	0.60	0.60	0.60	0.60	0.60	1.00
Settle.sup	SupAndSup	1.00	1.00	1.00	1.00	1.00	1.00
EQ.sup	SupAndSup						
LM3-Fatigue.s	SupAndSup						
		Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	Characteristic

		Comb 7	Comb 8	Comb 9	Comb 10	Comb 11	Comb 12
SUM-SW	SupAddLc	1.00	1.00	1.00	1.00	1.00	1.00 / 1.35
SUM-SDL	SupAddLc	1.00	1.00	1.00	0.90 / 1.10	0.90 / 1.10	1.00 / 1.35
SUM-PT	SupAddLc	0.90 / 1.10	0.90 / 1.10	0.90 / 1.10	0.90 / 1.10	0.90 / 1.10	1.00
SUM-CSt0	SupAddLc	1.00	1.00	1.00	1.00	1.00	1.00
SUM-CStinf	SupAddLc	1.00		1.00		1.00	
SUM-CStinf	SupAndLc						1.00
LM1-TS.sup	SupAndSup	0.75	0.75	0.75			1.35
LM1-UDL.sup	SupAndSup	0.40	0.40	0.40			1.35
Pedestrian.su	SupAndSup	0.40	0.40	0.40			1.35
Brake.sup	SupAndSup						
WindS+T.sup	SupAndSup						
Temp.sup	SupAndSup	1.00	0.50	0.50	0.50	0.50	
Settle.sup	SupAndSup	1.00	1.00	1.00	1.00	1.00	
EQ.sup	SupAndSup						
LM3-Fatigue.s	SupAndSup						
		Characteristic	Frequent com	Frequent com	Quasi-perman	Quasi-perman	Fundamental

		Comb 13	Comb 14	Comb 15	Comb 16	Comb 17	Comb 18
SUM-SW	SupAddLc	1.00 / 1.35	1.00 / 1.35	1.00 / 1.35	1.00 / 1.35	1.00	0.90 / 1.10
SUM-SDL	SupAddLc	1.00 / 1.35	1.00 / 1.35	1.00	1.00 / 1.35	1.00	1.00

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		Combinations					
LF/SUP	Rule	(+) / (-)	(+) / (-)	(+) / (-)	(+) / (-)	(+) / (-)	(+) / (-)
SUM-PT	SupAddLc	1.00	1.00	1.00	1.00	1.00	0.90 / 1.10
SUM-CSt0	SupAddLc	1.00	1.00	1.00	1.00	1.00	1.00
SUM-CStinf	SupAddLc				1.00		
SUM-CStinf	SupAndLc	1.00	1.00			1.00	
LM1-TS.sup	SupAndSup	1.35	1.35	1.01	1.01		
LM1-UDL.sup	SupAndSup	1.35	1.35	0.54	0.54		
Pedestrian.su	SupAndSup			0.54	0.54		
Brake.sup	SupAndSup			1.35			
WindS+T.sup	SupAndSup	0.90					
Temp.sup	SupAndSup		0.90		1.50		0.50
Settle.sup	SupAndSup						1.00
EQ.sup	SupAndSup					1.00	
LM3-Fatigue.s	SupAndSup						1.00
		Fundamental	Fundamental	Fundamental	Fundamental	Seismic combi	Fatigue

		Comb 19					
SUM-SW	SupAddLc	1.00					
SUM-SDL	SupAddLc	1.00					
SUM-PT	SupAddLc	0.90 / 1.10					
SUM-CSt0	SupAddLc	1.00					
SUM-CStinf	SupAddLc	1.00					
SUM-CStinf	SupAndLc						
LM1-TS.sup	SupAndSup						
LM1-UDL.sup	SupAndSup						
Pedestrian.su	SupAndSup						
Brake.sup	SupAndSup						
WindS+T.sup	SupAndSup						
Temp.sup	SupAndSup	0.50					
Settle.sup	SupAndSup	1.00					
EQ.sup	SupAndSup						
LM3-Fatigue.s	SupAndSup	1.00					
		Fatigue					

Description: 2 Combinations

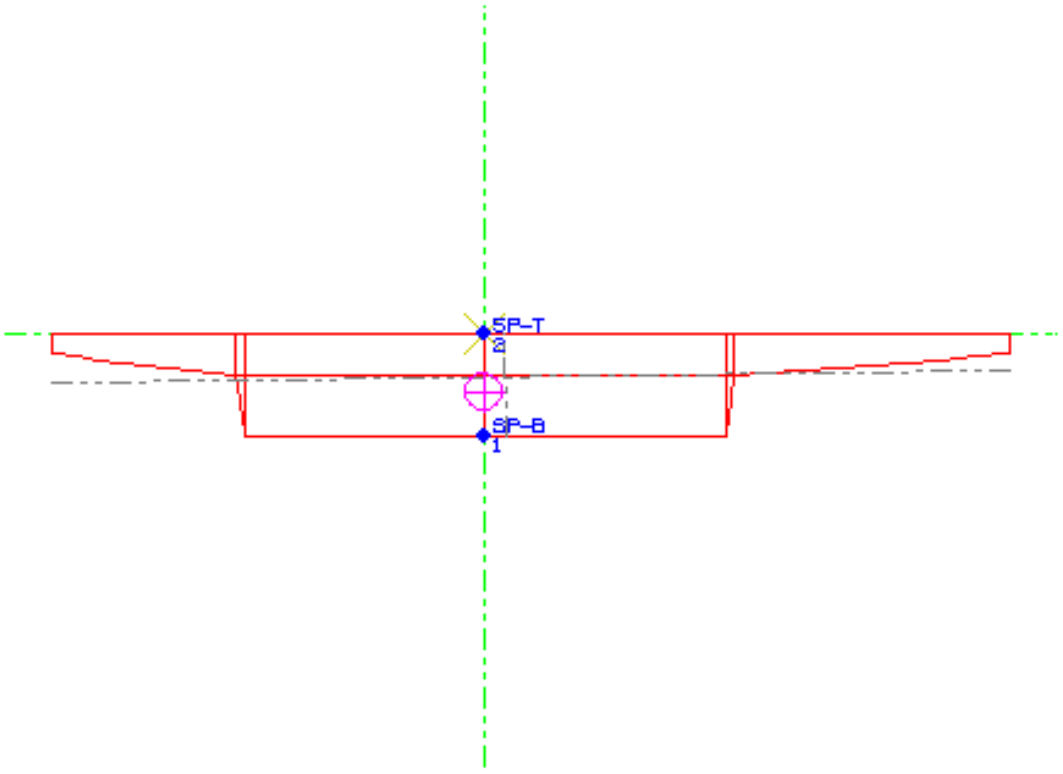
Project No.

Cross-section : MG001

Part : 1 Variant : 1

Reference set : Stress

Description : MG



C R O S S - S E C T I O N D A T A

Cross-section area	0.75800E+01	m2
Shear area - Bending about Z-axis	0.13582E+01	m2
Shear area - Bending about Y-axis	0.69306E+01	m2
Torsional moment of inertia I	0.22490E+01	m4
Shear lag factor X [Ax-shear/Ax]	0.10000E+01	
Moment of inertia about Y-axis	0.39696E+02	m4
Section moment about Y-axis - min	0.80967E+01	m3
Section moment about Y-axis - max	0.72089E+01	m3
Eccentricity Z (Shear lag)	0.00000E+00	m
Shear lag factor Y	0.10000E+01	
Moment of inertia about Y-axis (Shear Lag)	0.39696E+02	m4
Moment of inertia about Z-axis	0.79514E+00	m4
Section moment about Z-axis - min	0.12620E+01	m3
Section moment about Z-axis - max	0.17103E+01	m3
Eccentricity Y (Shear lag)	0.00000E+00	m
Shear lag factor Z	0.10000E+01	
Moment of inertia about Z-axis (Shear Lag)	0.79514E+00	m4
Warping moment of inertia	0.16545E+01	m6
Bending axis origin - Eccentricity ay	-0.45492	m
Bending axis origin - Eccentricity az	0.21428	m
Main axis angle	0.72318	Deg
Shear axis origin - Eccentricity ay	-0.62421	m
Shear axis origin - Eccentricity az	-0.01455	m
Main axis angle - Shear	0.00000	Deg
Y-below : Gravity centre - minY	0.63508	m
Y-above : Gravity centre - maxY	0.46492	m
Z-left : Gravity centre - minZ	4.92928	m
Z-right : Gravity centre - maxZ	5.61072	m
Perimeter exposed to drying (outside)	22.48923	m
Perimeter (inside)	0.00000	m

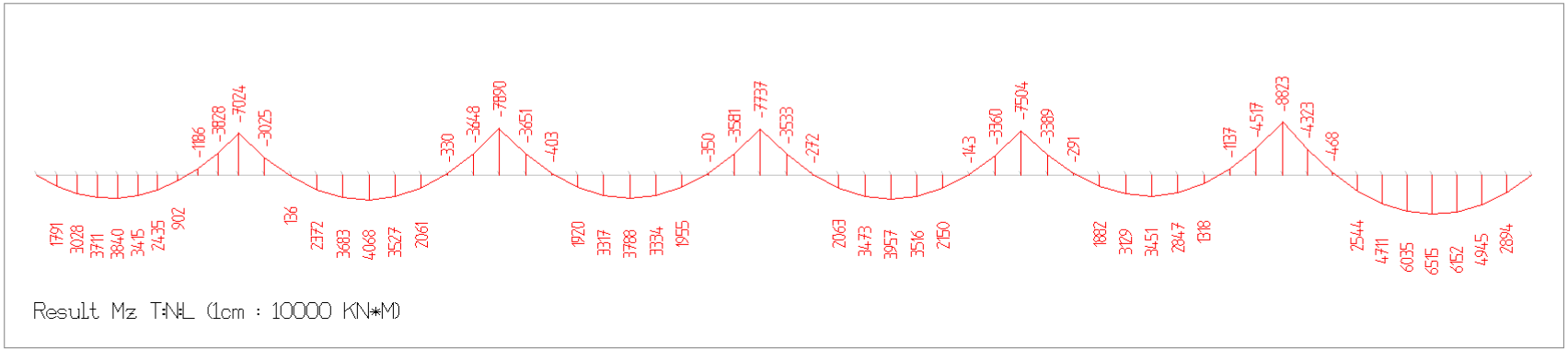
4.3. АНАЛИЗА СУПЕРСТРУКТУРЕ – ПОДУЖНИ ПРАВАЦ

STRUCTURAL ANALYSIS – LONGITUDINAL DIRECTION

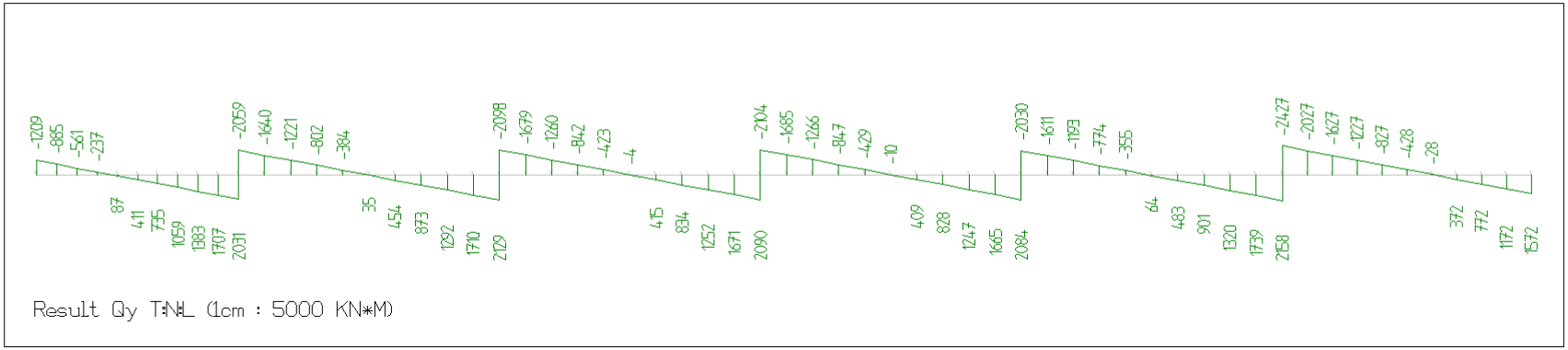
4.3.1. ДИЈАГРАМИ УТИЦАЈА ЗА ПОЈЕДИНАЧНА ОПТЕРЕЋЕЊА

Diagrams by load case

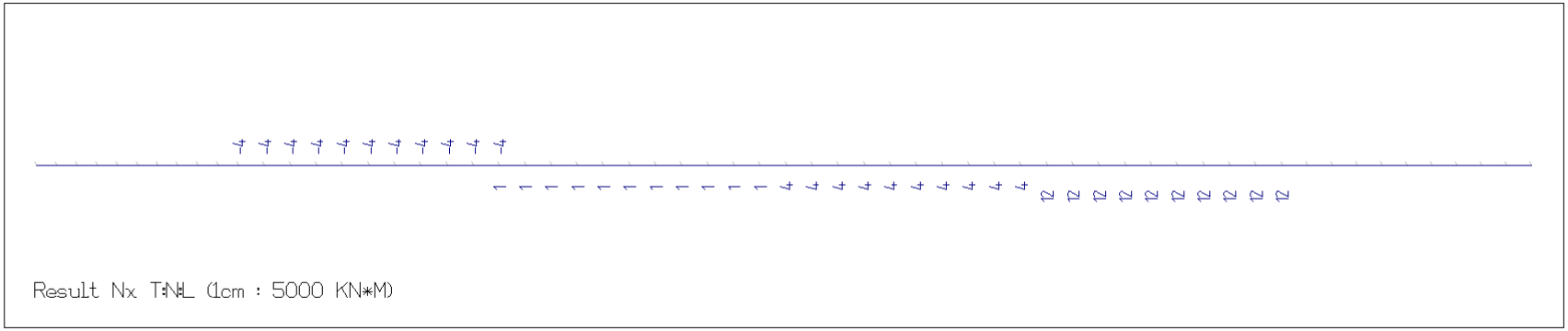
Results Load Case SUM-SW
Stage Loads-P1, elevation view



Result Mz TENL (1cm : 10000 KN*M)

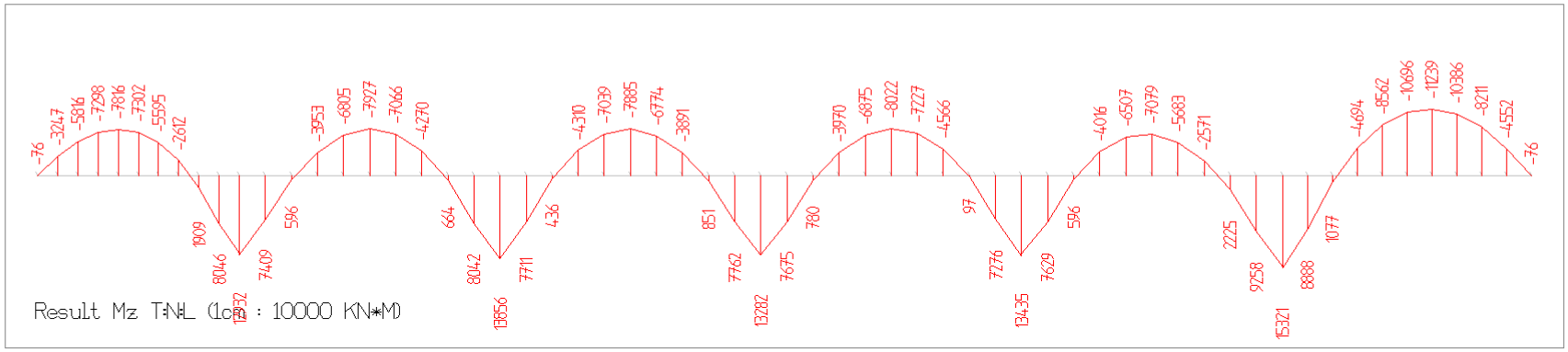


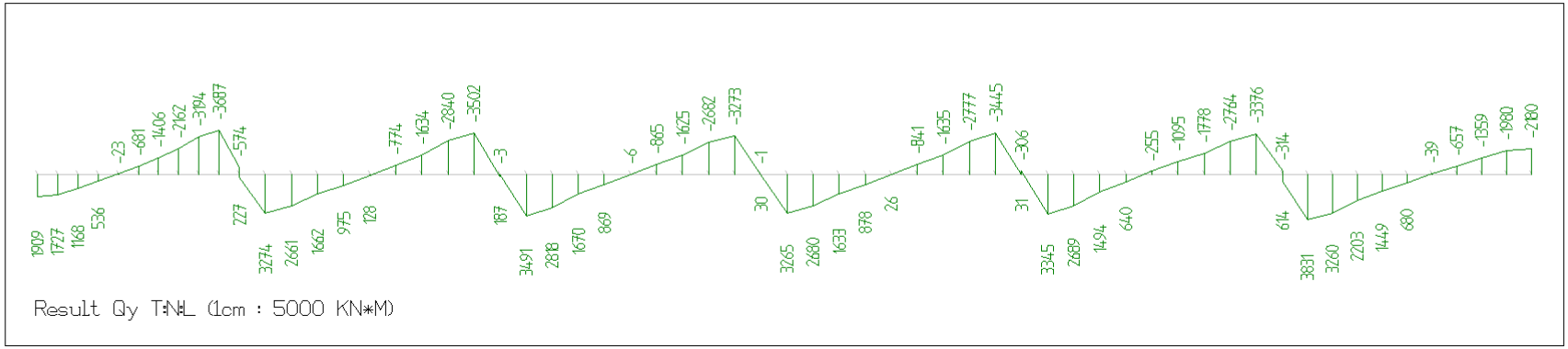
Result Qy TENL (1cm : 5000 KN*M)

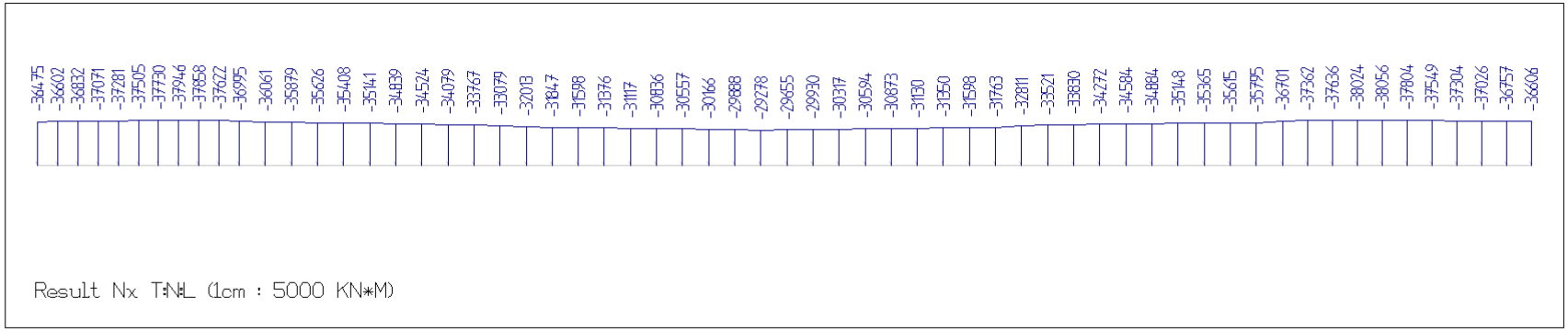


Result Nx TENL (1cm : 5000 KN*M)

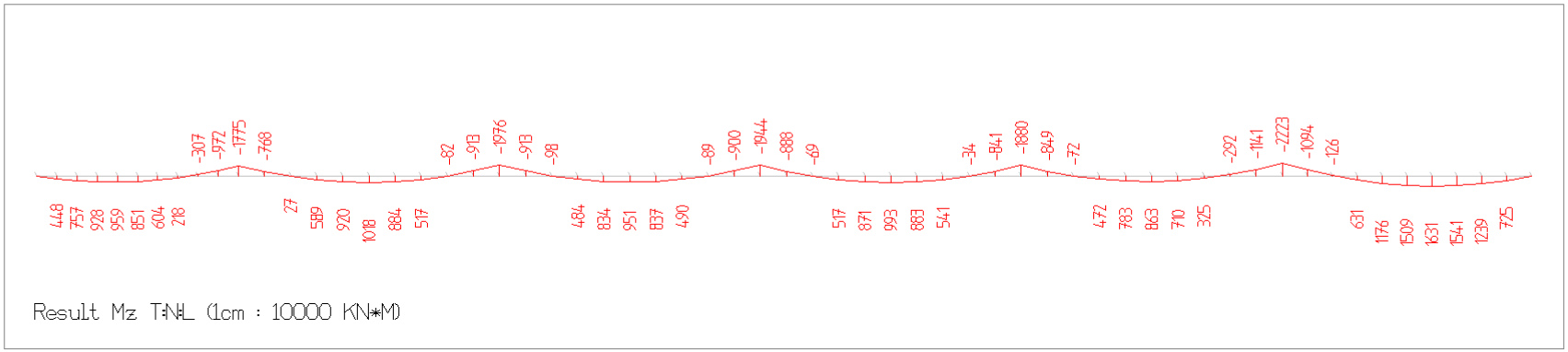
Results Load Case SUM-PT
Stage Loads-P1, elevation view



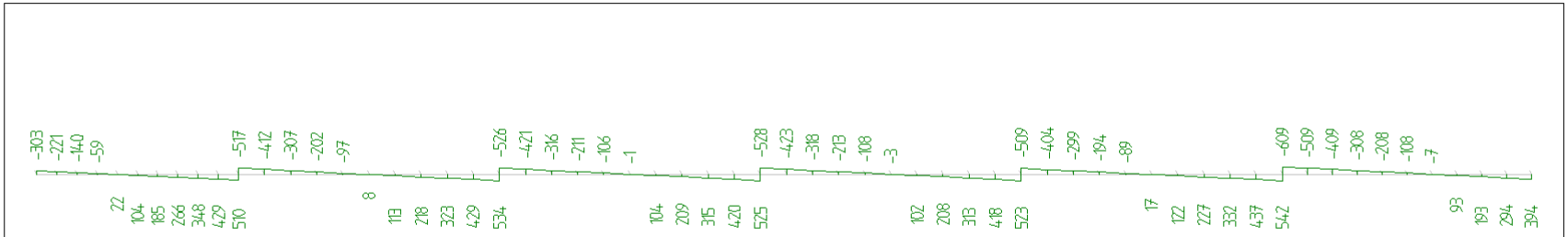




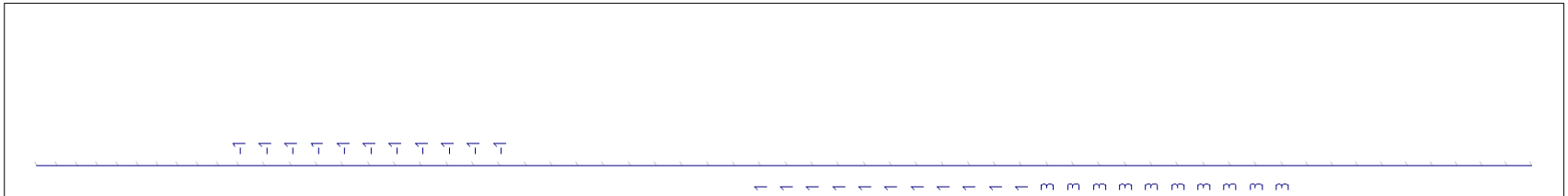
Results Load Case SUM-SDL
Stage Loads-P1, elevation view



Result Mz T:\#L (1cm : 10000 KN*M)

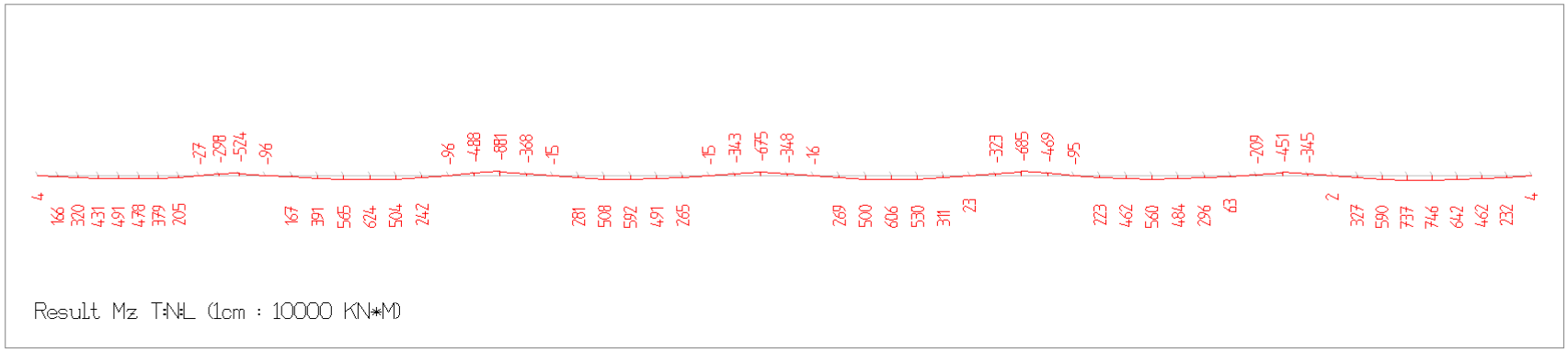


Result Qy T:\#L (1cm : 5000 KN*M)

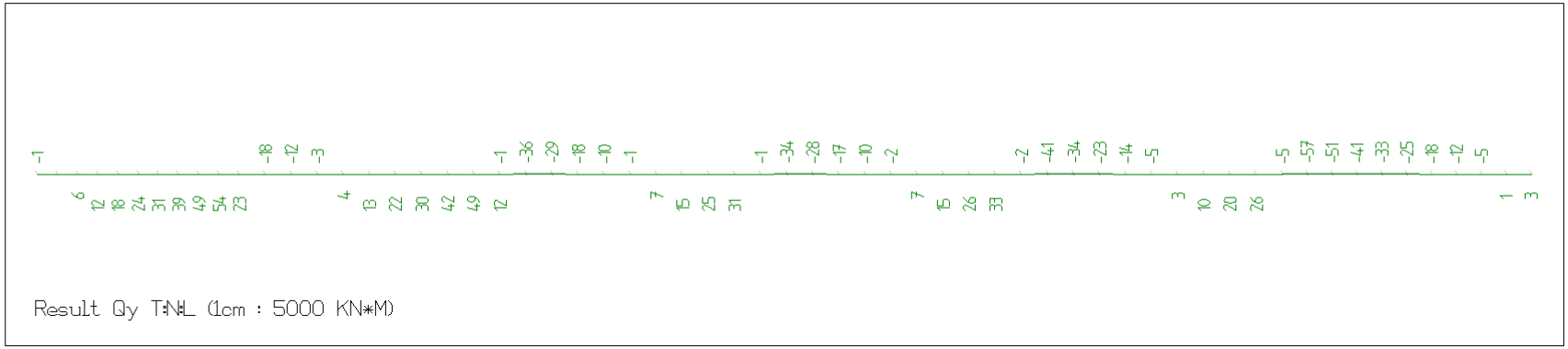


Result Nx T:\#L (1cm : 5000 KN*M)

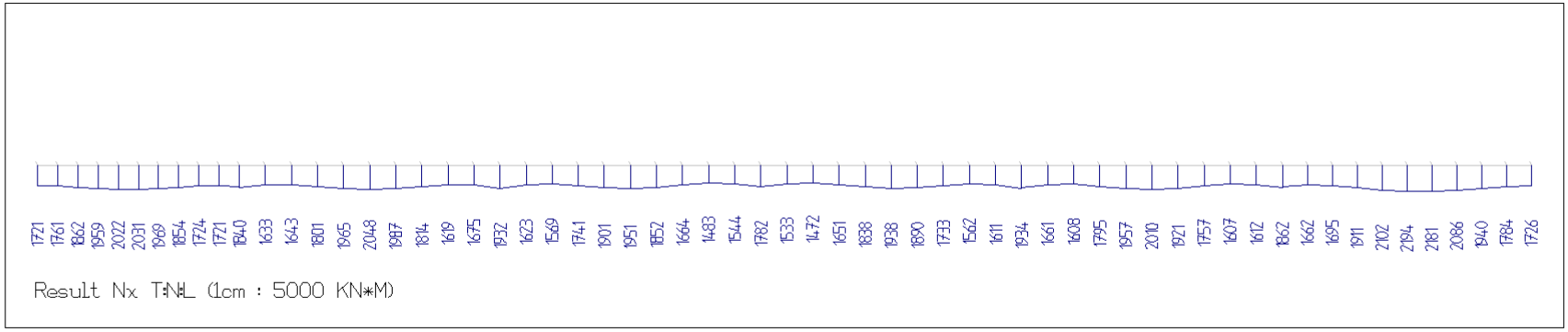
Results Load Case SUM-CSt0
Stage Loads-Pl, elevation view



Result Mz T:NL (1cm : 10000 KN*M)

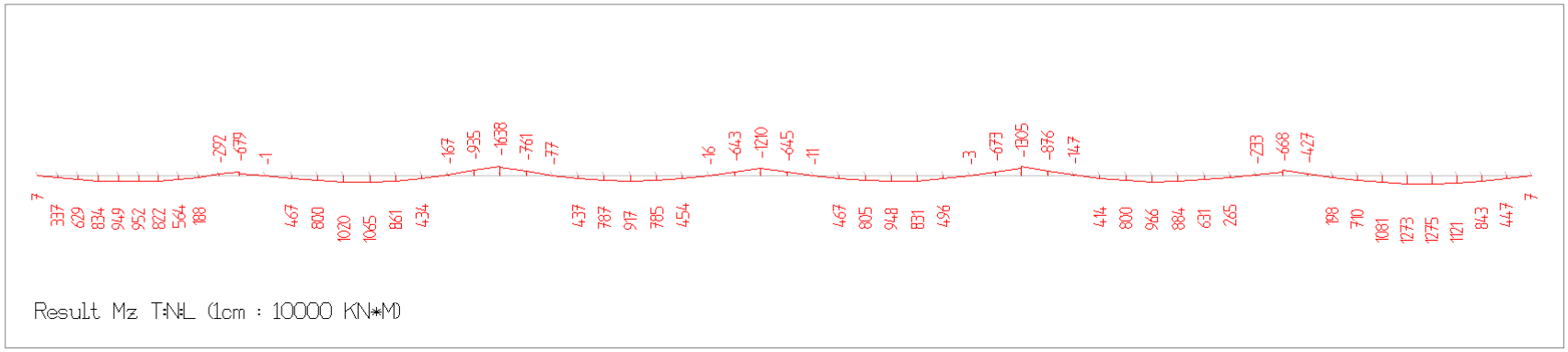


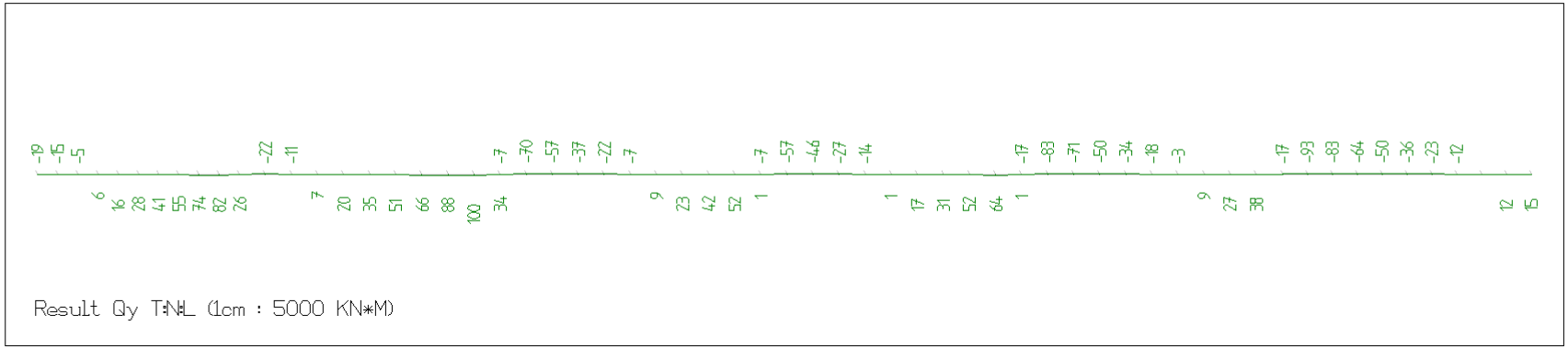
Result Qy T:NL (1cm : 5000 KN*M)

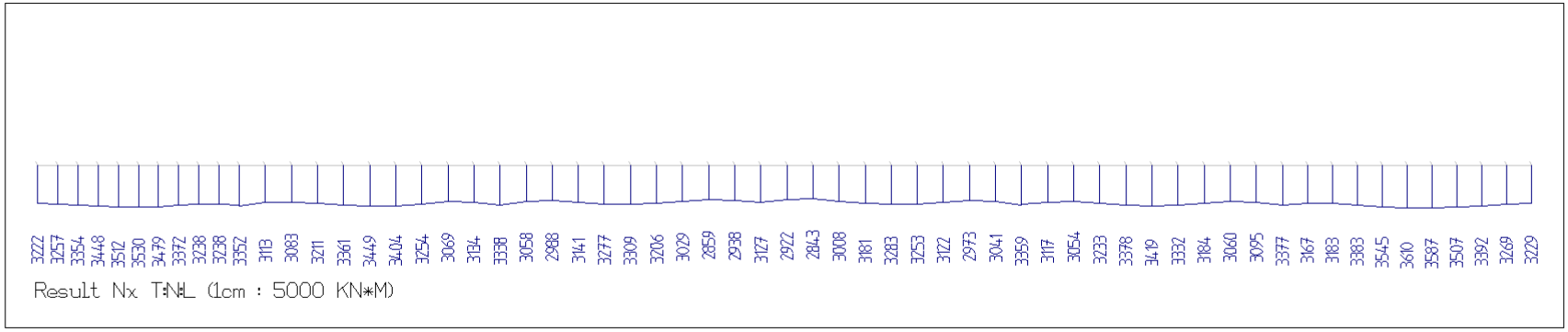


Result Nx T:NL (1cm : 5000 KN*M)

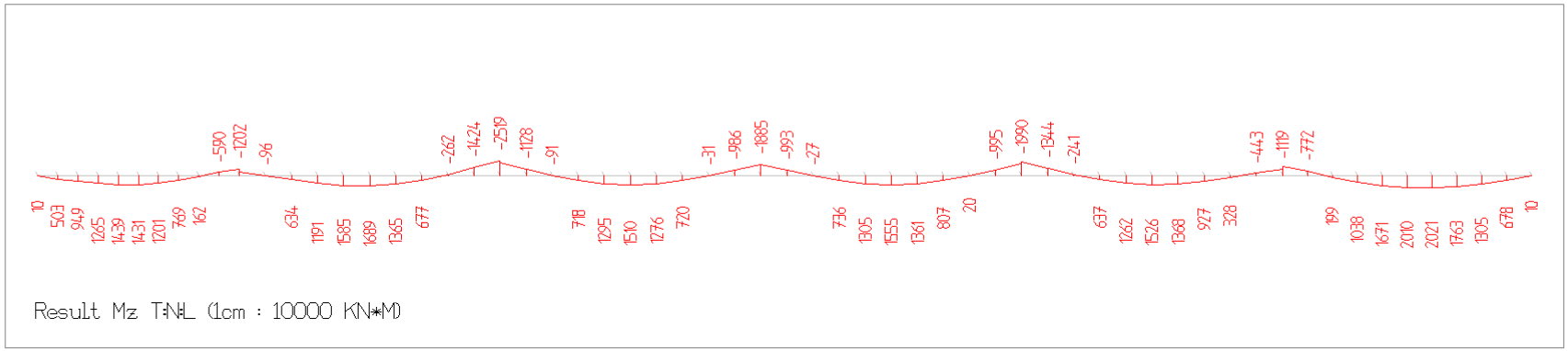
Results Load Case SUM-CStinf
Stage Loads-Pl, elevation view

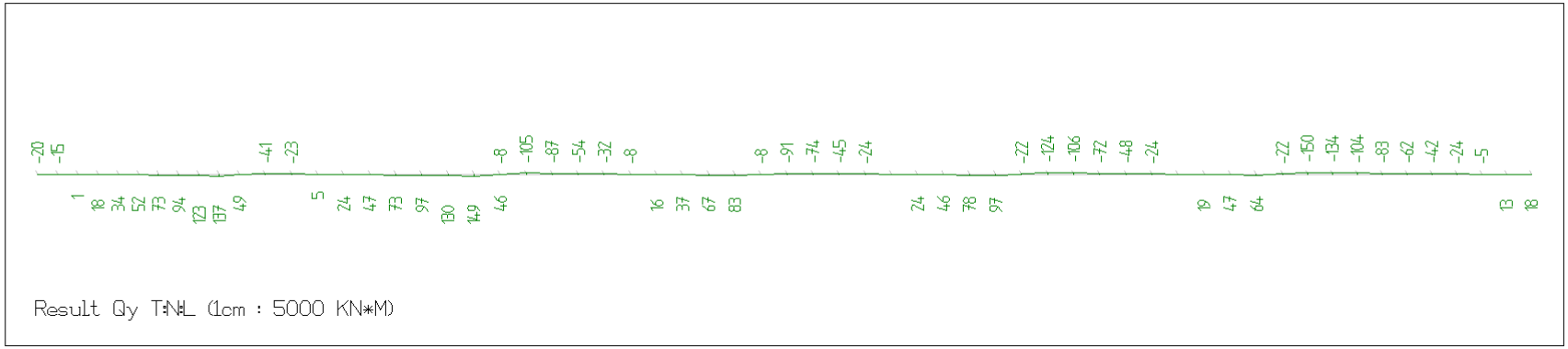


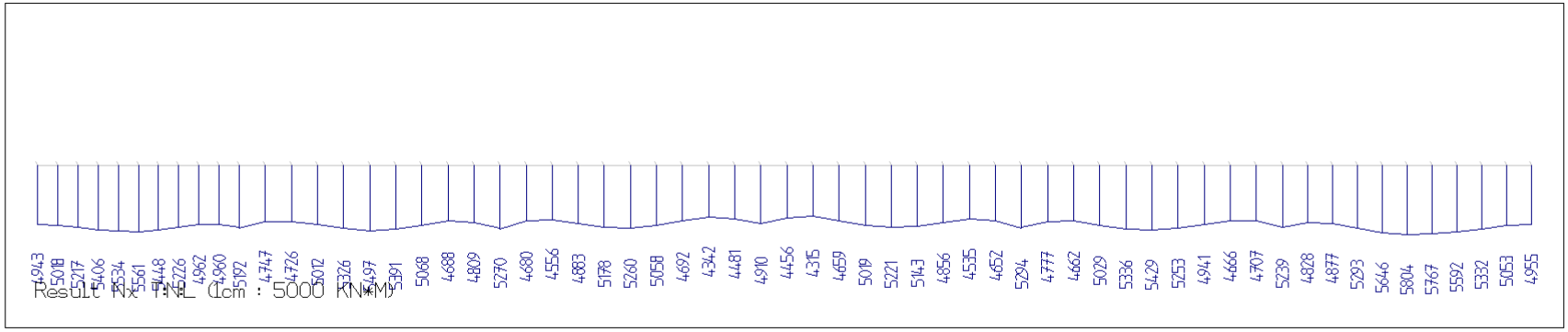


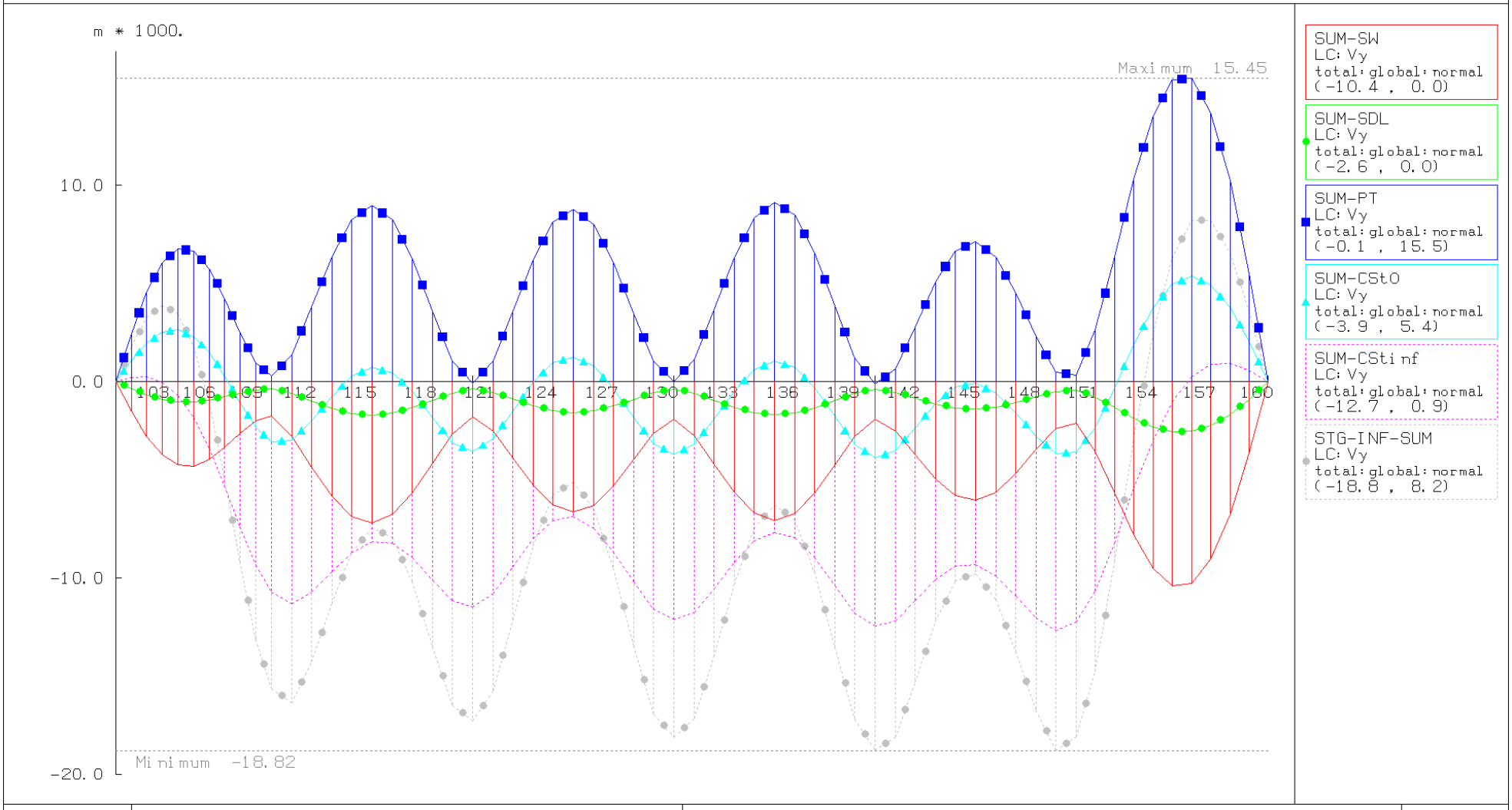


Results Load Case SUM-CS
Stage Loads-PL, elevation view









MX Bridge Enterprise CONNECT Edition
11.04.00.17 [64 bit]

Author: only § ::LAVTeam::r

Project:

Displacements Vx

RmSet: Vy, Stage: Loads-Pl

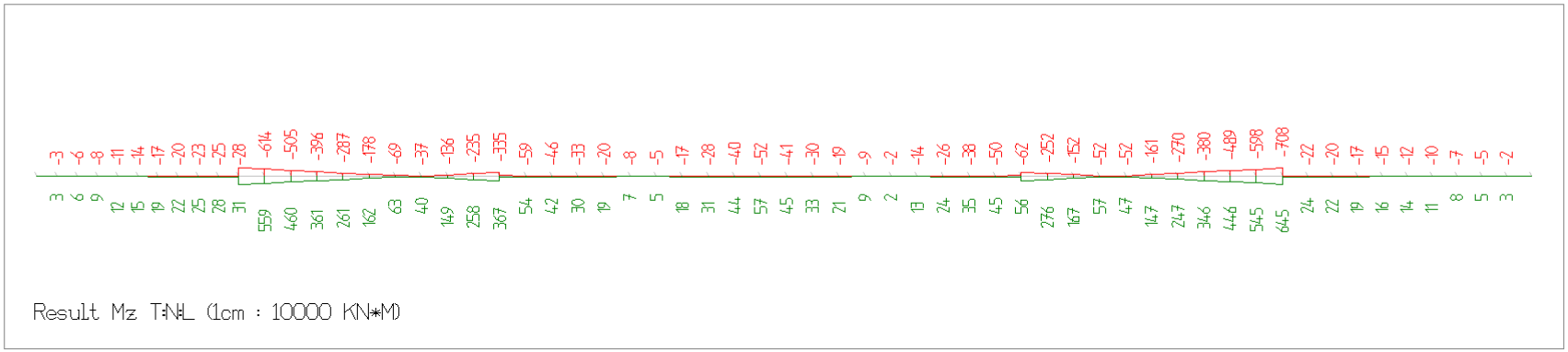
(DefaultSchedule)/107+Vy+SW+SDL+PT+CSt0+CStinf

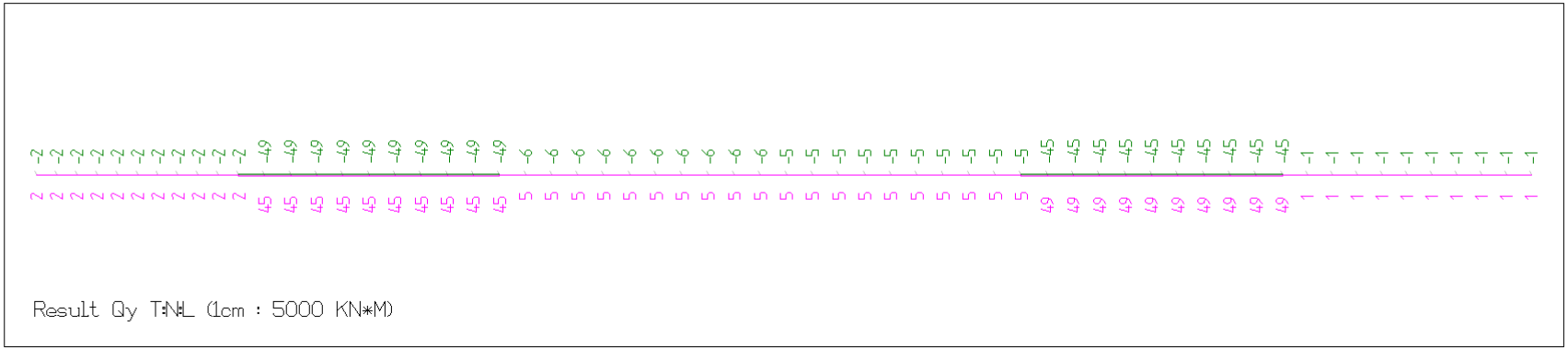
1 cm Plot = 0.00272 m

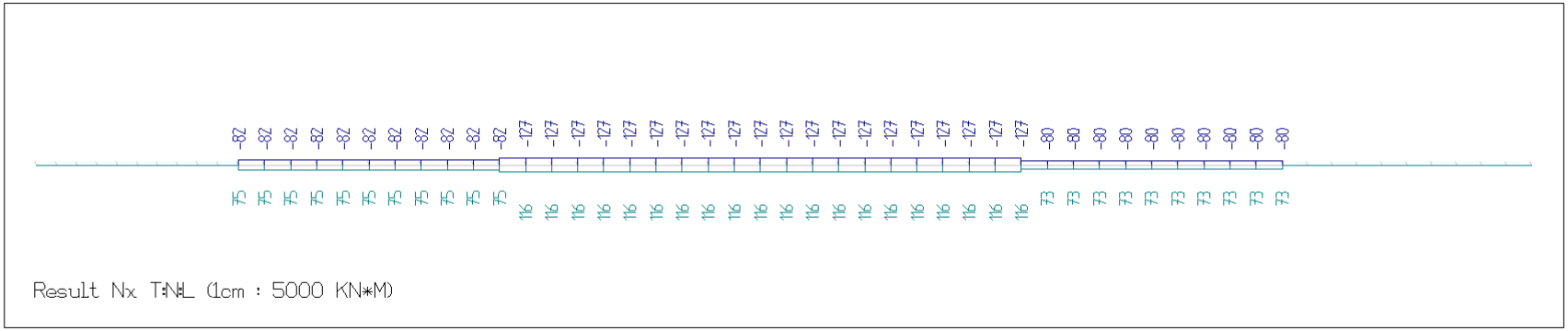
0 0.00272 0.00543 0.00815 0.01086 0.01358

17/03/2021
17:54

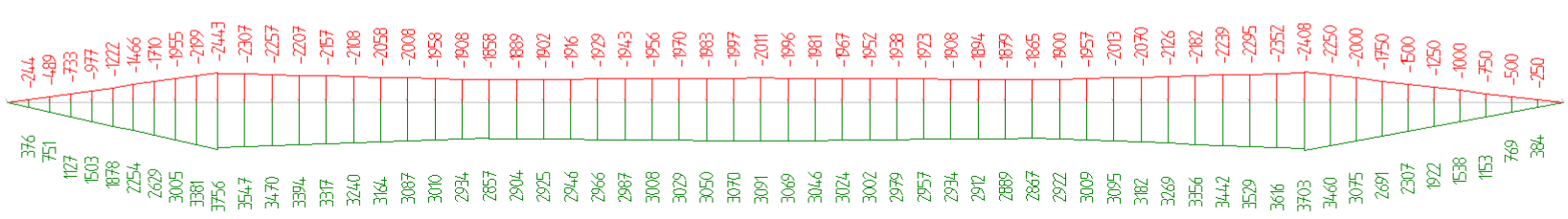
Results Envelope Temp-U.sup
Stage Loads-P1, elevation view



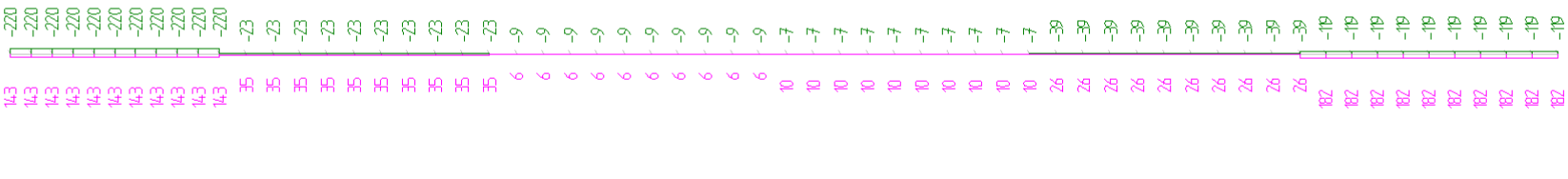




Results Envelope TempG.sup
Stage Loads-P1, elevation view



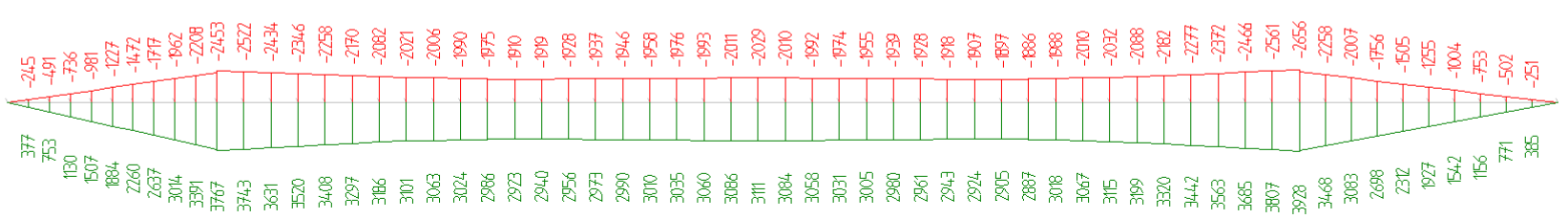
Result Mz T:NL (1cm : 10000 KN*M)



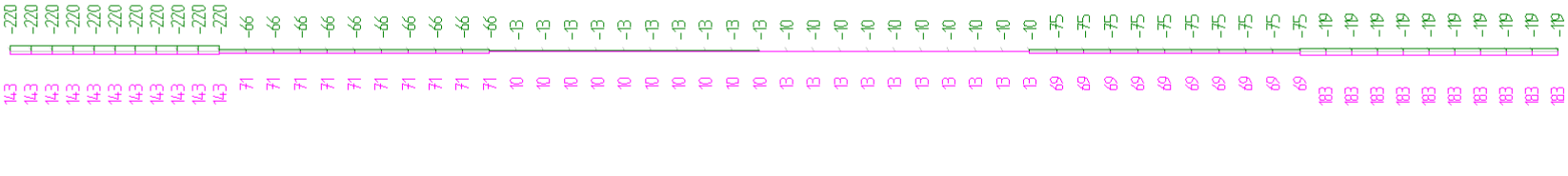
Result Qy T:NL (1cm : 5000 KN*M)

Result Nx T:NL (1cm : 5000 KN*M)

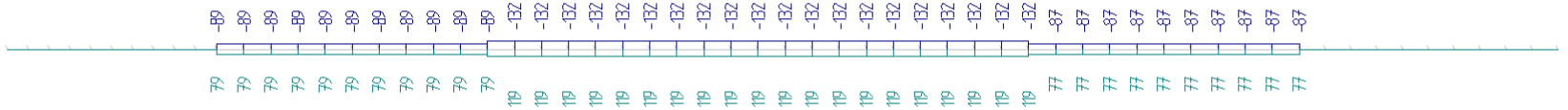
Results Envelope Temp.sup
Stage Loads-PL, elevation view



Result Mz TENL (1cm : 10000 KN*M)

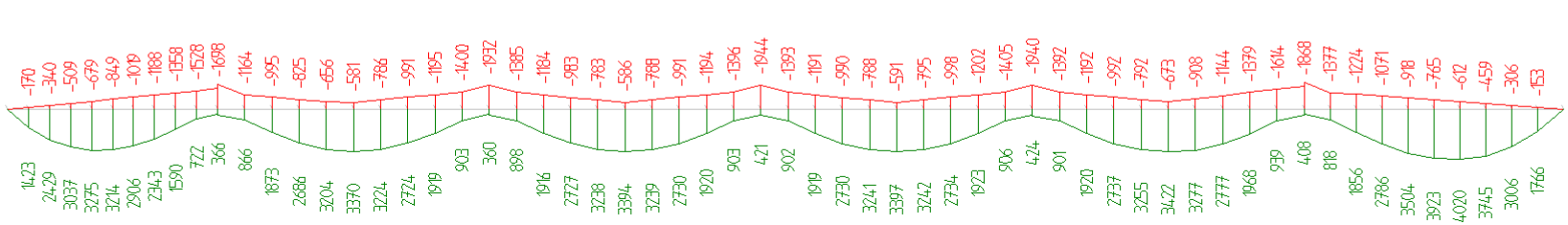


Result Qy TENL (1cm : 5000 KN*M)

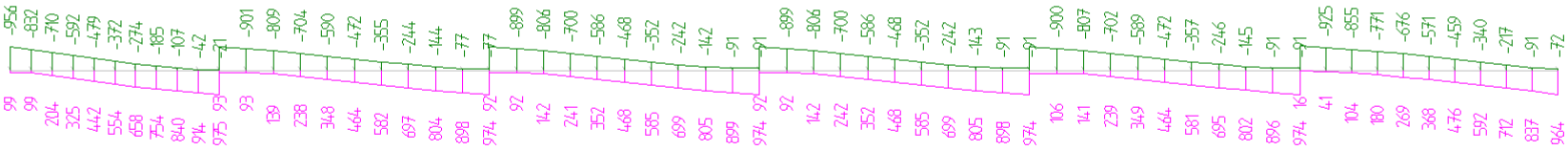


Result Nx TENL (1cm : 5000 KN*M)

Results Envelope LM1-TS.sup
Stage Loads-P1, elevation view



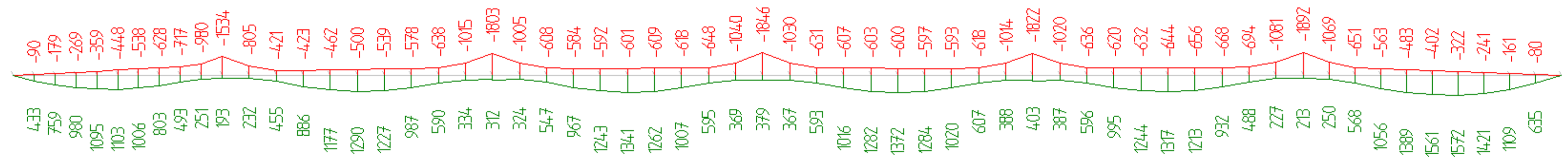
Result Mz T:\#L (1cm : 10000 KN*M)



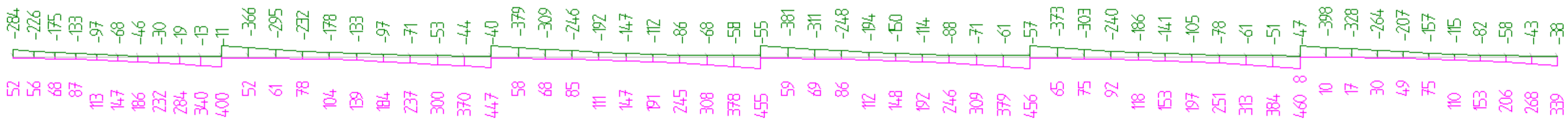
Result Qy T:\#L (1cm : 5000 KN*M)

Result Nx T:\#L (1cm : 5000 KN*M)

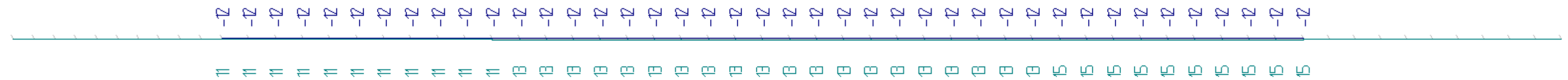
Results Envelope LM1-UDL.sup
Stage Loads-P1, elevation view



Result Mz T:N:L (1cm : 10000 KN*M)



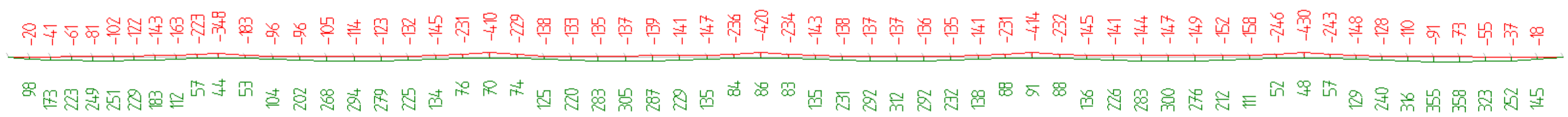
Result Qy T:N:L (1cm : 5000 KN*M)



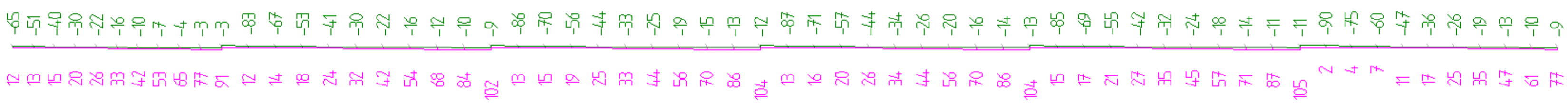
Result Nx T:N:L (1cm : 5000 KN*M)

Plot 'SUP-stgLoads-P1.pl' from 17 MAR 2021

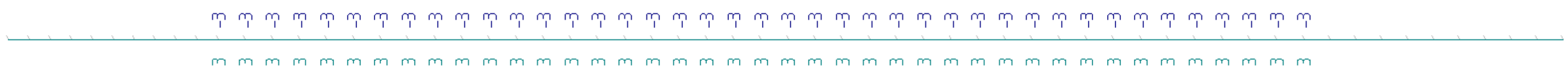
Results Envelope Pedestrian.sup
Stage Loads-P1, elevation view



Result Mz T:N:L (1cm : 10000 KN*M)



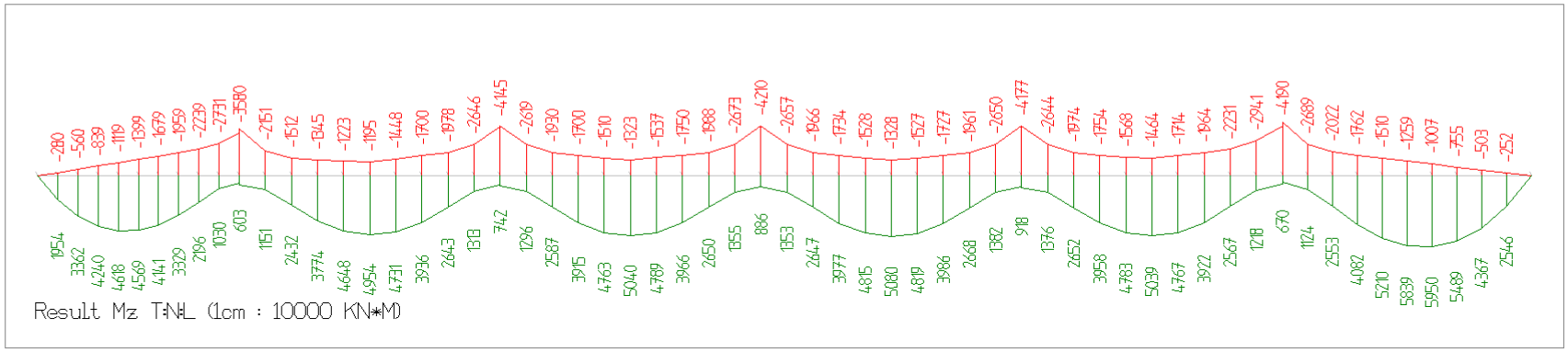
Result Qy T:N:L (1cm : 5000 KN*M)

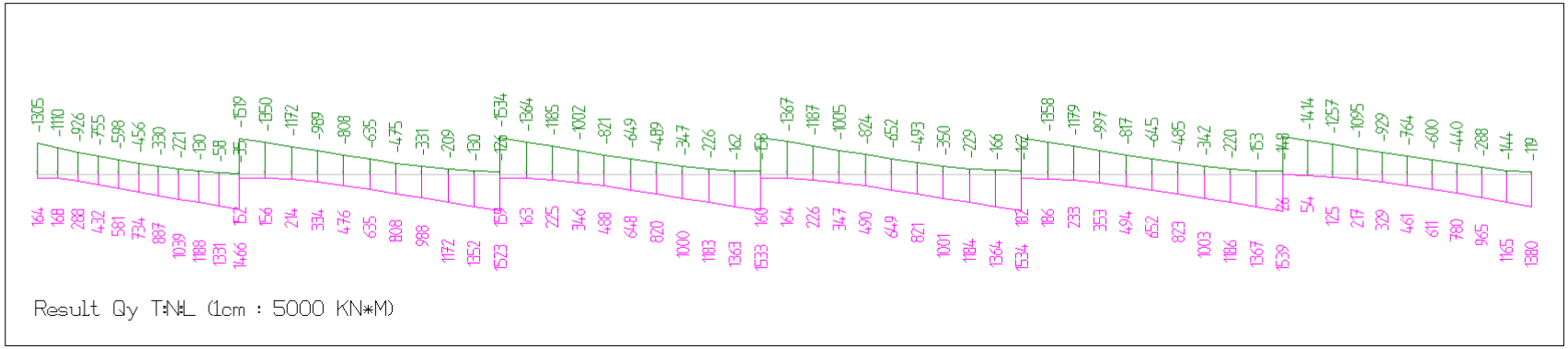


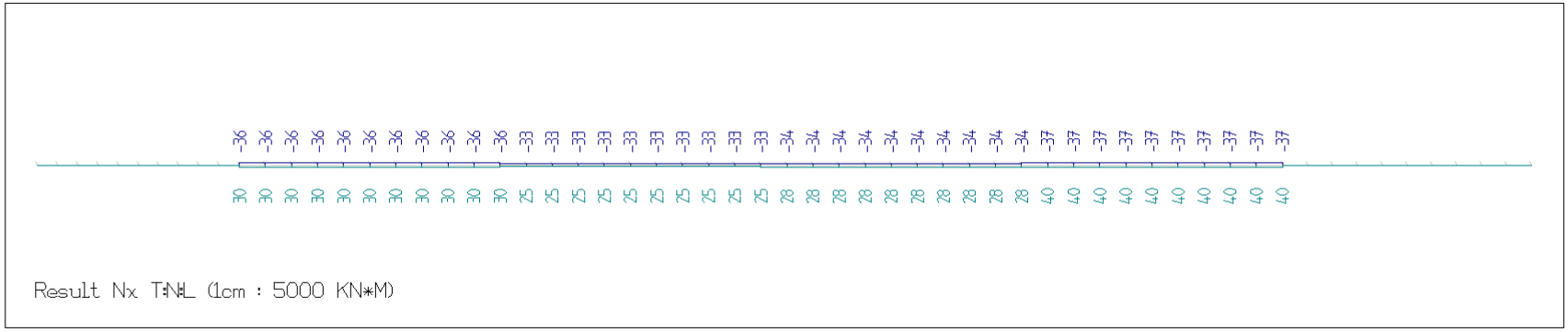
Result Nx T:N:L (1cm : 5000 KN*M)

Plot 'SUP-stgLoads-P1.pl' from 17 MAR 2021

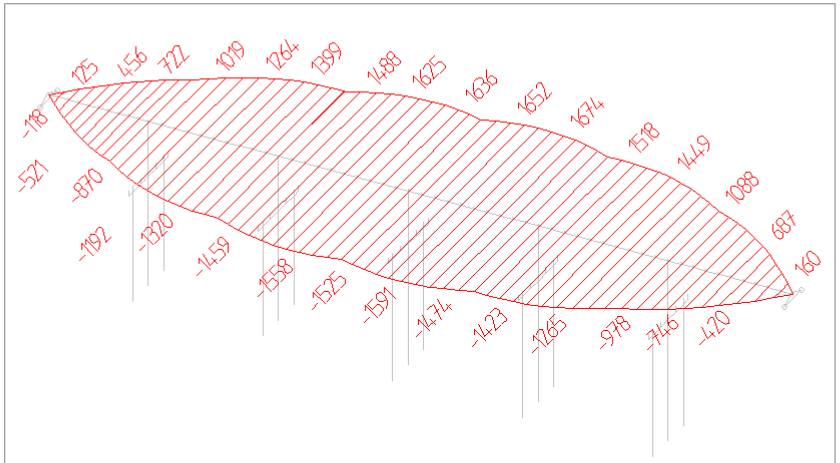
Results Envelope Traffic.sup
Stage Loads-PL, elevation view



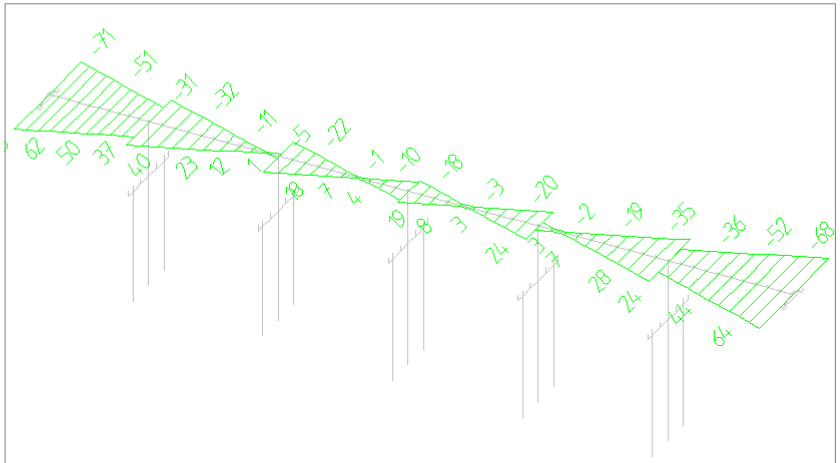




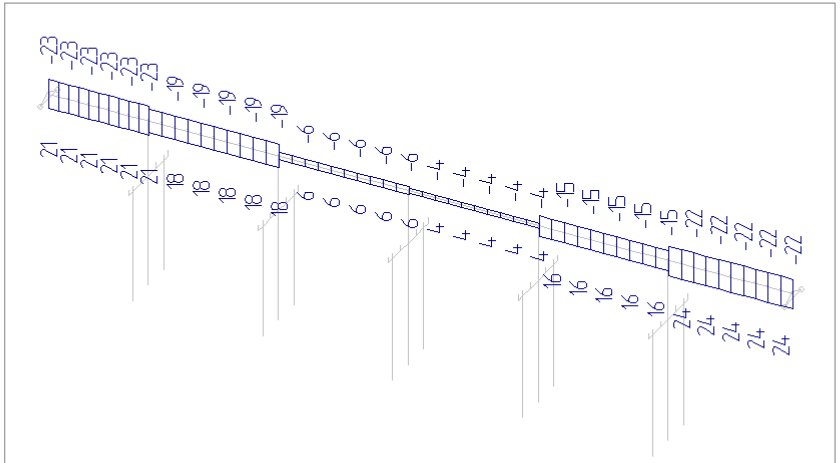
Superposition-Results WindS+T.sup
Stage Loads-Pl, elevation view



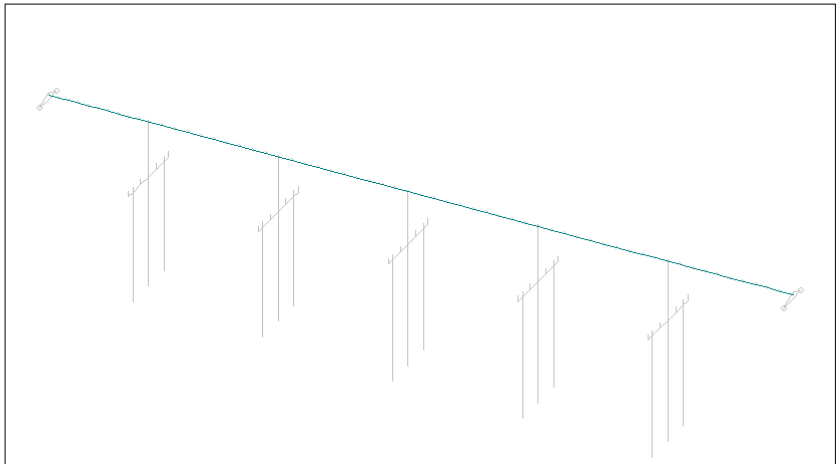
Result MIN+MAX My:My T:N:L (1cm : 1000 KN*M)



Result MIN+MAX Qz:Qz T:N:L (1cm : 100 KN)

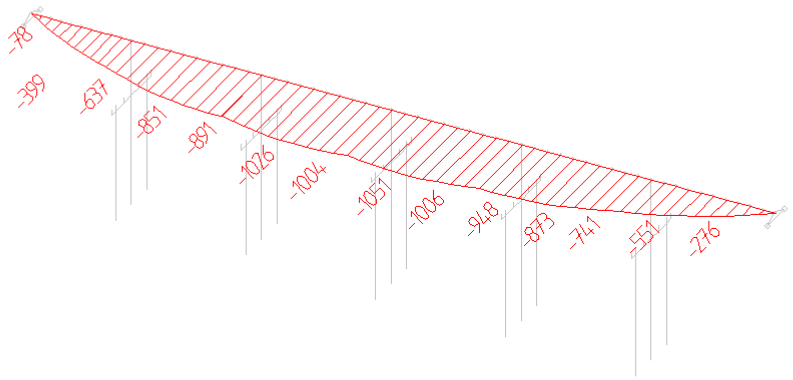


Result MIN+MAX Mx:Mx T:N:L (1cm : 100 KN*M)

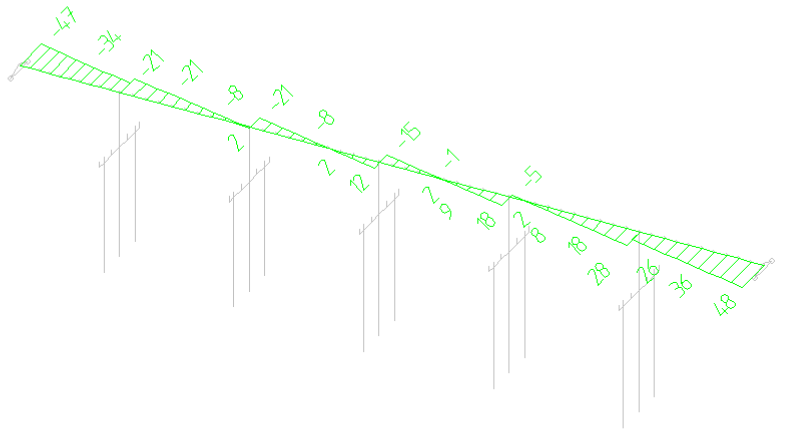


Result MIN+MAX Nx:Nx T:N:L (1cm : 5000 KN)

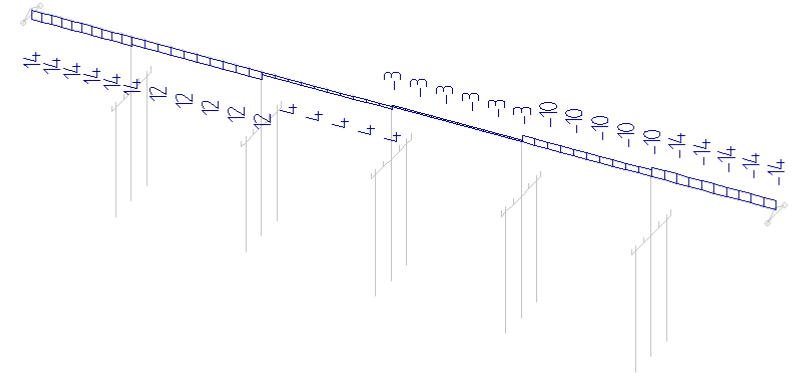
Superposition-Results WindS-T.sup
Stage Loads-Pl, elevation view



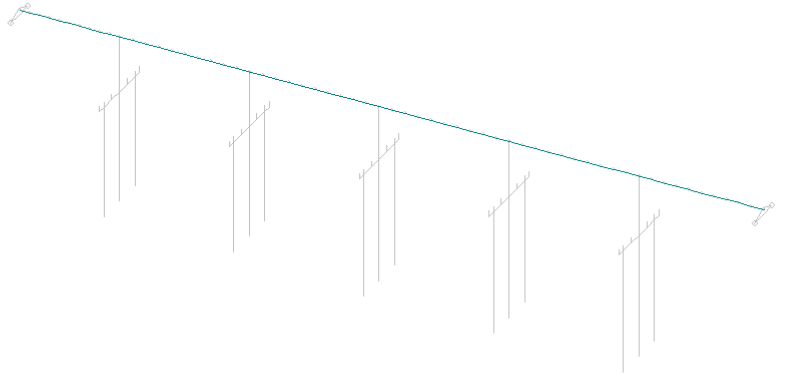
Result MIN+MAX My:My T:N:L (1cm : 1000 KN*M)



Result MIN+MAX Qz:Qz T:N:L (1cm : 100 KN)

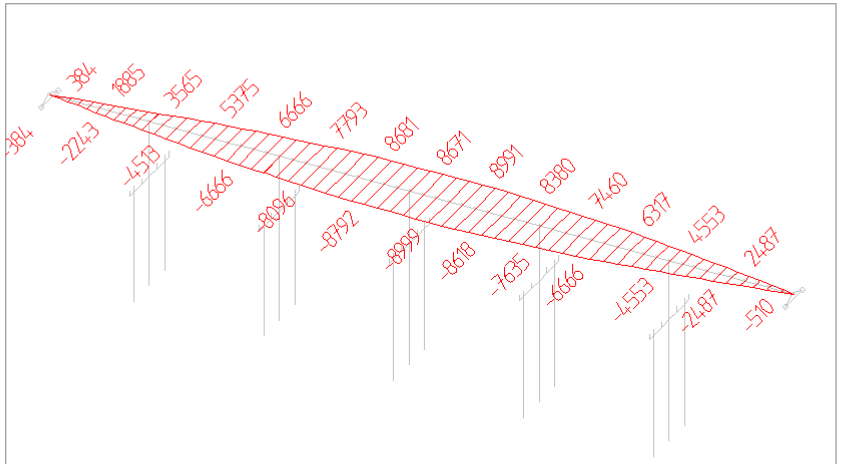


Result MIN+MAX Mx:Mx T:N:L (1cm : 100 KN*M)

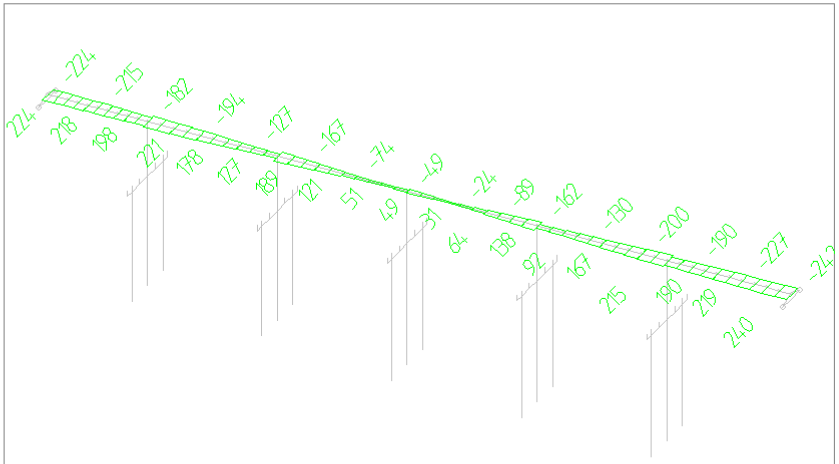


Result MIN+MAX Nx:Nx T:N:L (1cm : 5000 KN)

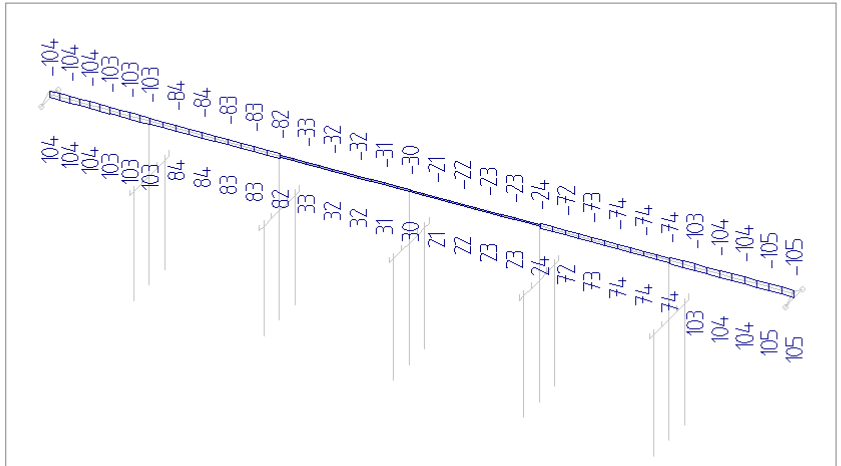
Superposition-Results EQ.sup
Stage Loads-Pl, elevation view



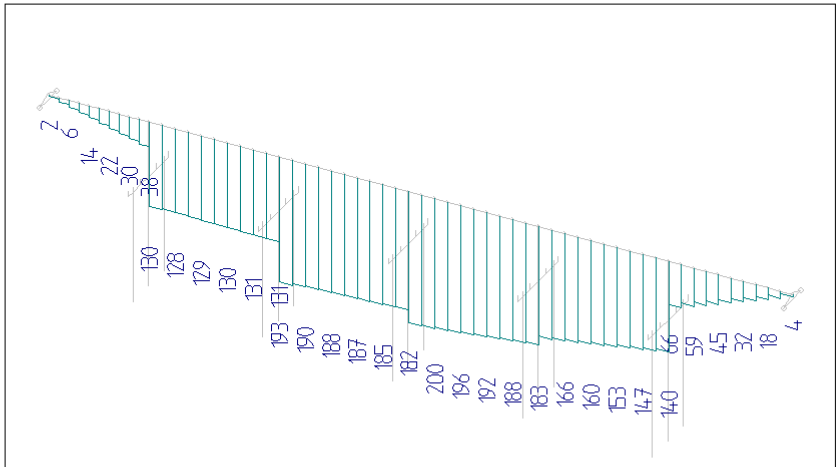
Result MIN+MAX My:My T:N:L (1cm : 20000 KN*M)



Result MIN+MAX Qz:Qz T:N:L (1cm : 2000 KN)

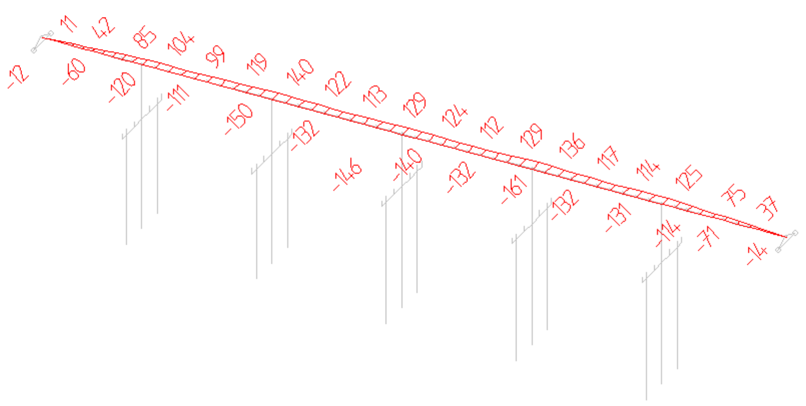


Result MIN+MAX Mx:Mx T:N:L (1cm : 2000 KN*M)

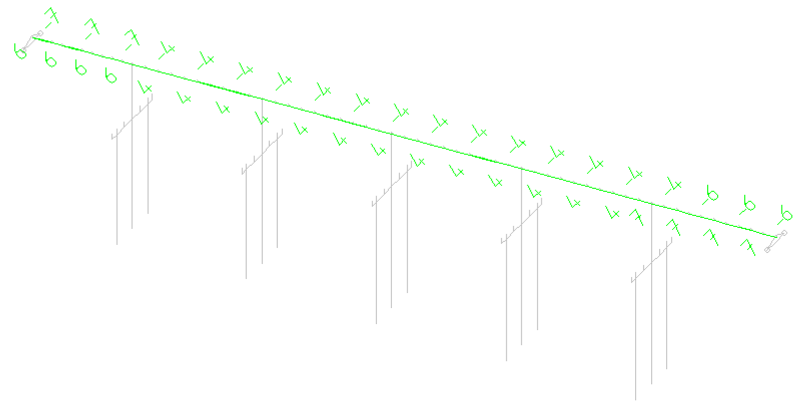


Result MIN+MAX Nx:Nx T:N:L (1cm : 100 KN)

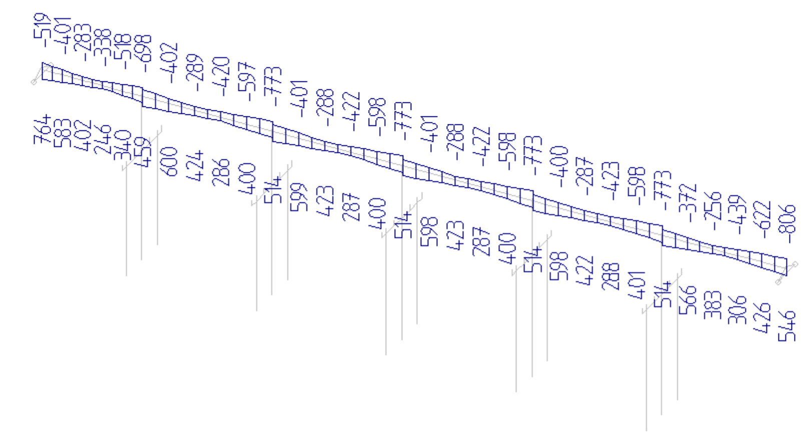
Superposition-Results LM3-Fatigue.sup
Stage Loads-Pl, elevation view



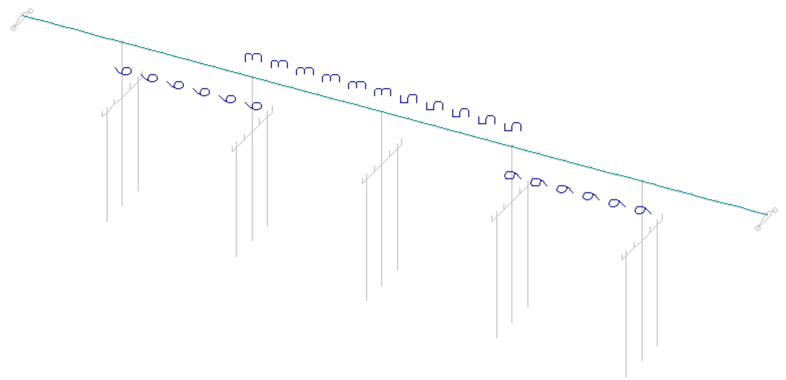
Result MIN+MAX My:My T:N:L (1cm : 1000 KN*M)



Result MIN+MAX Qz:Qz T:N:L (1cm : 5000 KN)



Result MIN+MAX Mx:Mx T:N:L (1cm : 5000 KN*M)



Result MIN+MAX Nx:Nx T:N:L (1cm : 50000 KN)

Plot 'MG-Fatigue-stgLoads-Pl.pl' from 17 MAR 2021

4.3.2. КОНТРОЛА ГРАНИЧНОГ СТАЊА УПОТРЕБЉИВОСТИ

Analysis at the serviceability limit state

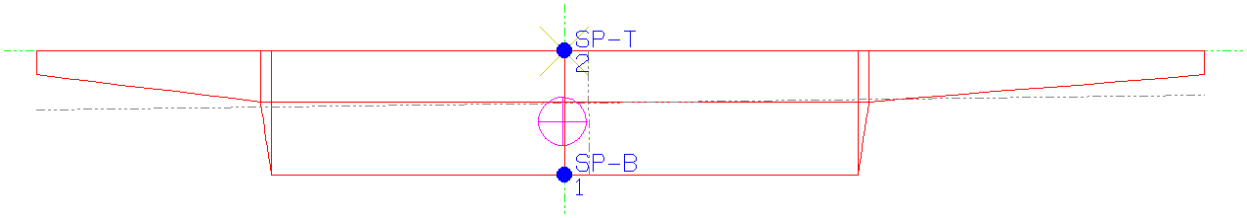
4.3.2.1. Комбинације за проверу граничног стања употребљивости sls

Combinations for SLS check

ЛЕГЕНДА /LEGEND:

Stress: SP-T (max/min) - **максимални и минимални напони у горњем влакну** /
Maximum and minimum values at top fiber

Stress: SP-B (max/min) - **максимални и минимални напони у доњем влакну** /
Maximum and minimum values at bottom fiber



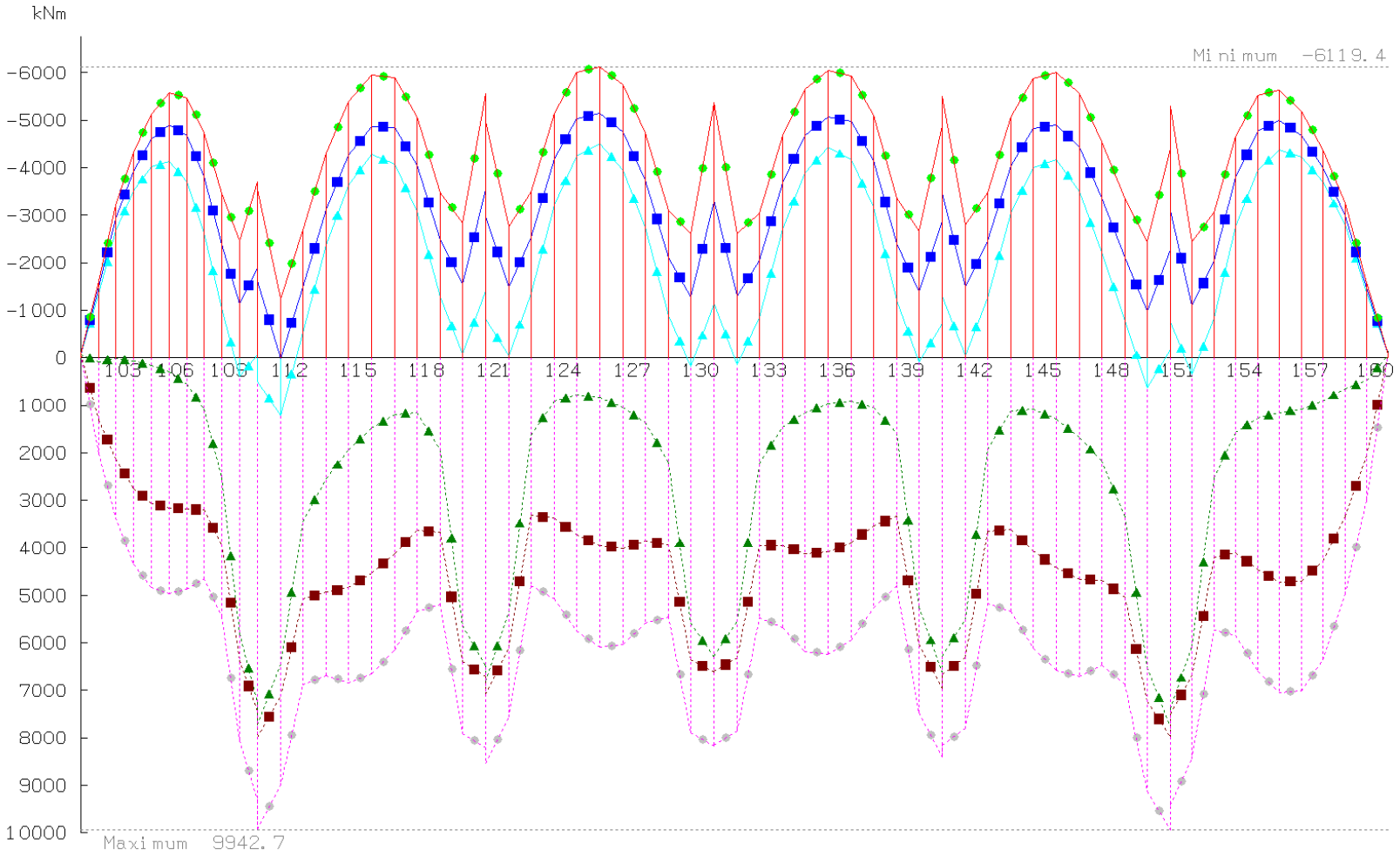
Envelope SLS.sup - Combinations 1-11
Envelope SLS-charac.sup – Combinations 1-7
Envelope Frequent.sup - Combinations 8-9
Envelope Quasi-perm.sup - Combinations 10-11

Сумирани приказ комбинација које улазе у анвелопу за проверу граничног стања употребљивости (SLS) / All combinations for SLS check**:**

		Combination 1		Combination 2		Combination 3		Combination 4		Combination 5		Combination 6		Combination 7		Combination 8		Combination 9		Combination 10	
		Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.
SUM-SW	SupAddLc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SUM-SDL	SupAddLc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.9	1.1
SUM-PT	SupAddLc	1	1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1
SUM-CSt0	SupAddLc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SUM-CStinf	SupAddLc					1	1			1	1			1	1			1	1		
SUM-CStinf	SupAndLc		1																		
LM1-TS.sup	SupAndSup		1		1		1		1		1		0.75		0.75		0.75		0.75		
LM1-UDL.sup	SupAndSup		1		1		1		1		1		0.4		0.4		0.4		0.4		
Pedestrian.sup	SupAndSup								1		1		0.4		0.4		0.4		0.4		
Brake.sup	SupAndSup																				
WindS-T.sup	SupAndSup																				
WindS+T.sup	SupAndSup		0.6		0.6		0.6														
Temp.sup	SupAndSup		0.6		0.6		0.6		0.6		0.6		1		1		0.5		0.5		0.5
Settle.sup	SupAndSup		1		1		1		1		1		1		1		1		1		1
EQ.sup	SupAndSup																				
LM3-Fatigue.sup	SupAndSup																				
		Characteristic con		Characteristic con		Characteristic con		Characteristic con		Characteristic con		Characteristic con		Characteristic con		Frequent combina		Frequent combina		Quasi-permanent	

		Combination 11		Combination 12		Combination 13		Combination 14		Combination 15		Combination 16		Combination 17		Combination 18		Combination 19	
		Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.	Favor.	Unfavor.
SUM-SW	SupAddLc	1	1	1	1.35	1	1.35	1	1.35	1	1.35	1	1.35	1	1	0.9	1.1	1	1
SUM-SDL	SupAddLc	0.9	1.1	1	1.35	1	1.35	1	1.35	1	1	1	1.35	1	1	1	1	1	1
SUM-PT	SupAddLc	0.9	1.1	1	1	1	1	1	1	1	1	1	1	1	1	0.9	1.1	0.9	1.1
SUM-CSt0	SupAddLc	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SUM-CStinf	SupAddLc	1	1									1	1					1	1
SUM-CStinf	SupAndLc				1		1		1						1				
LM1-TS.sup	SupAndSup				1.35		1.35		1.35		1.01		1.01						
LM1-UDL.sup	SupAndSup				1.35		1.35		1.35		0.54		0.54						
Pedestrian.sup	SupAndSup				1.35						0.54		0.54						
Brake.sup	SupAndSup										1.35								
WindS-T.sup	SupAndSup																		
WindS+T.sup	SupAndSup						0.9												
Temp.sup	SupAndSup		0.5						0.9				1.5				0.5		0.5
Settle.sup	SupAndSup		1														1		1
EQ.sup	SupAndSup														1				
LM3-Fatigue.sup	SupAndSup																1		1
		Quasi-permanent		Fundamental com		Fundamental com		Fundamental com		Fundamental com		Fundamental com		Seismic combinati		Fatigue		Fatigue	

Rule – **правило додавања оптерећења, безусловно или само за повољно дејство. Скупљање и течење се узима у оба случаја, као безусловно и као повољно дејство. Безусловно је са rule-add, повољно је са rule-and.** / rule for adding loads into combinations, unconditionally ot only favoruable case. Creep and shrinkage is taken double, one combination is with unconditional case and other only for favourable effect.



SLS. sup
MinMz: Mz
total: local: normal
(-6119 , -80)

SLS-charac. sup
MinMz: Mz
total: local: normal
(-6119 , -80)

Frequent. sup
MinMz: Mz
total: local: normal
(-5147 , 15)

Quasi-perm. sup
MinMz: Mz
total: local: normal
(-4507 , 1207)

SLS. sup
MaxMz: Mz
total: local: normal
(-58 , 9943)

SLS-charac. sup
MaxMz: Mz
total: local: normal
(-58 , 9943)

Frequent. sup
MaxMz: Mz
total: local: normal
(-58 , 7986)

Quasi-perm. sup
MaxMz: Mz
total: local: normal
(-58 , 7790)

RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

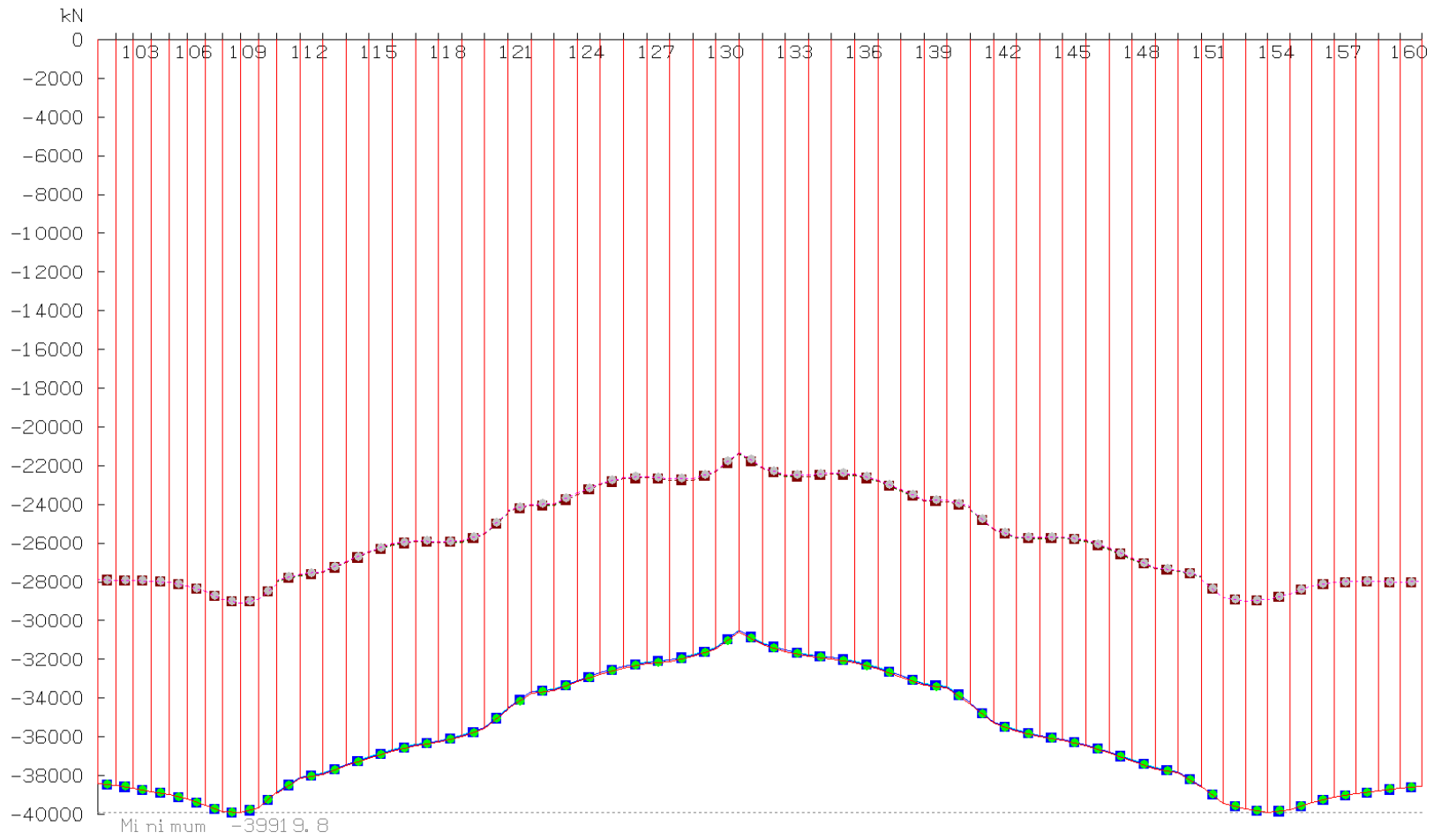
RmSet: SLS-Mz-MG, Stage: SLS-Pl

(DefaultSchedule)/201+SLS-Mz-MG

1 cm Plot = 1272.2 kNm

0 1272.2 2544.5 3816.7 5089.0 6361.2

01/04/2021
10:04



SLS. sup
MinNx: Nx
total: local: normal
(-39920 , -30577)

SLS-charac. sup
MinNx: Nx
total: local: normal
(-39920 , -30577)

Frequent. sup
MinNx: Nx
total: local: normal
(-39920 , -30511)

Quasi-perm. sup
MinNx: Nx
total: local: normal
(-39920 , -30491)

SLS. sup
MaxNx: Nx
total: local: normal
(-29110 , -21303)

SLS-charac. sup
MaxNx: Nx
total: local: normal
(-29110 , -21303)

Frequent. sup
MaxNx: Nx
total: local: normal
(-29110 , -21363)

Quasi-perm. sup
MaxNx: Nx
total: local: normal
(-29110 , -21376)

RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

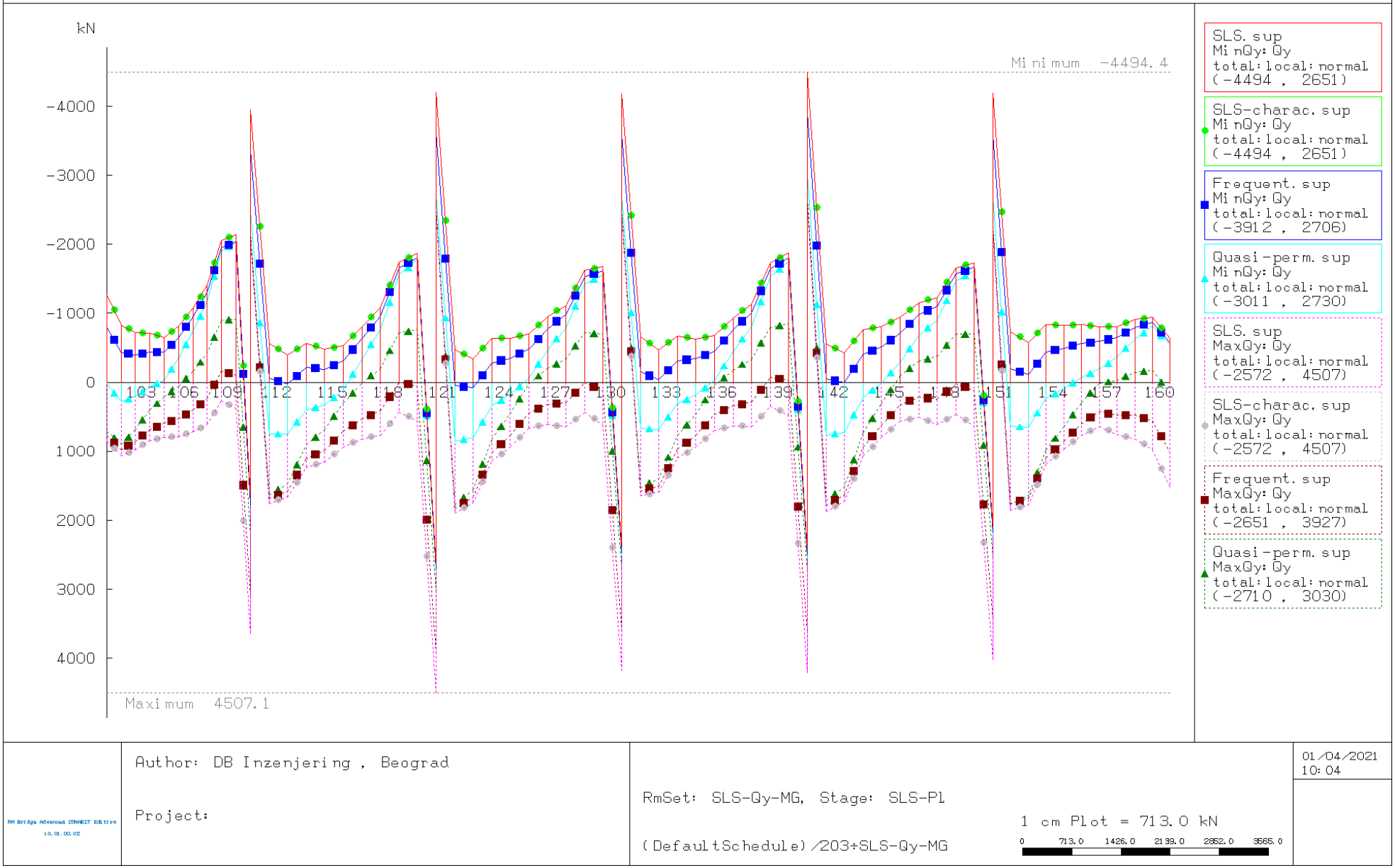
RmSet: SLS-Nx-MG, Stage: SLS-P1

(DefaultSchedule)/202+SLS-Nx-MG

1 cm Plot = 3162.0 kN

0 3162.0 6323.9 9485.9 12647.8 15809.8

01/04/2021
10:04



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

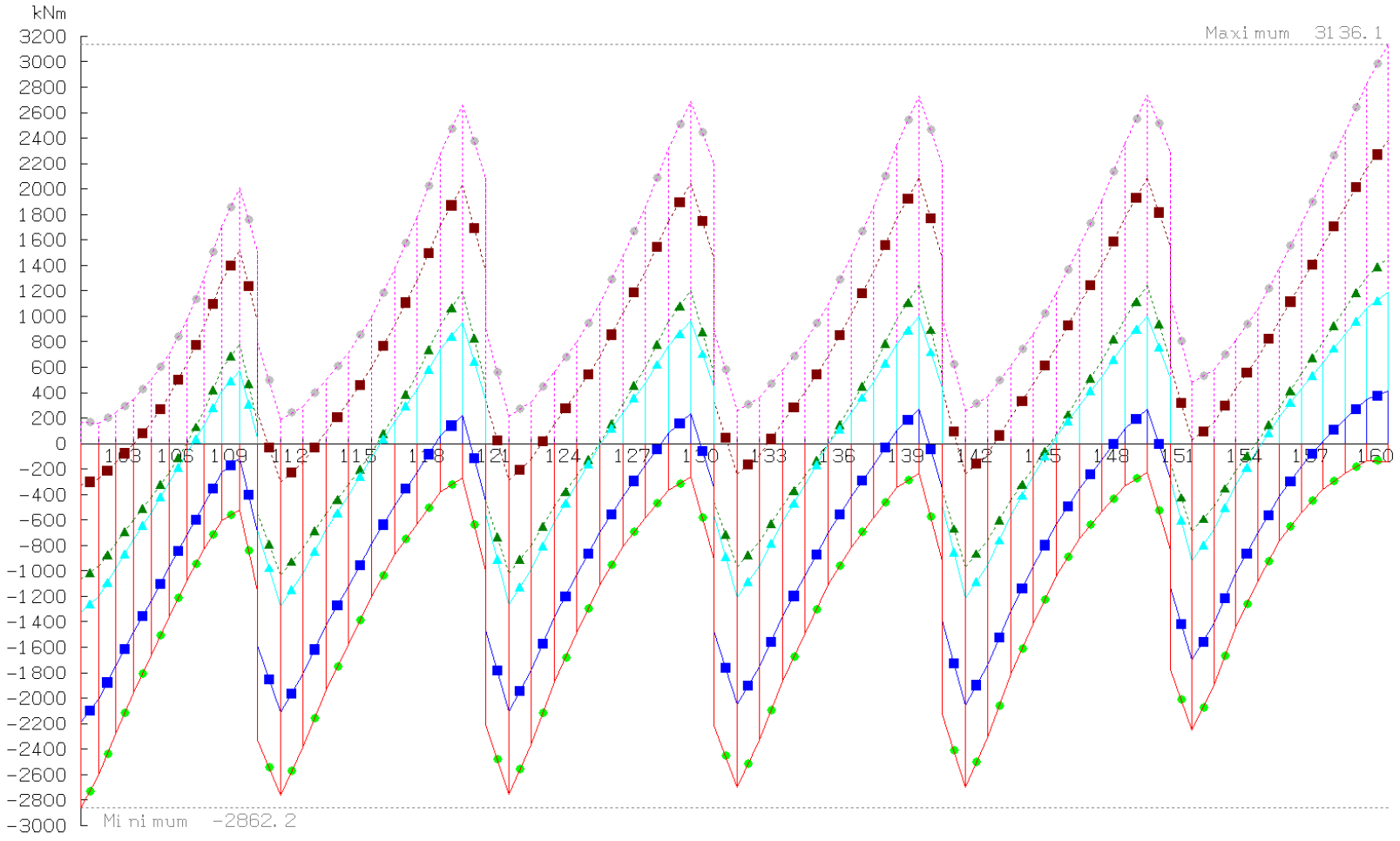
RmSet: SLS-Qy-MG, Stage: SLS-P1

(DefaultSchedule)/203+SLS-Qy-MG

1 cm Plot = 713.0 kN

0 713.0 1426.0 2139.0 2852.0 3565.0

01/04/2021
10:04



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

RmSet: SLS-Mx-MG, Stage: SLS-P1

(DefaultSchedule)/204+SLS-Mx-MG

1 cm Plot = 475.1 kNm

0 475.1 950.2 1425.3 1900.4 2375.5

01/04/2021
10:04

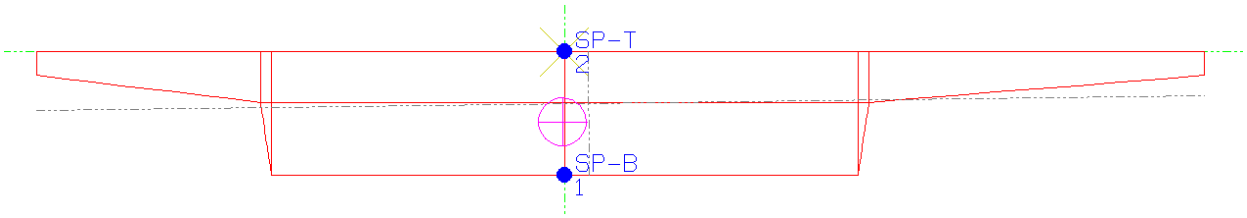
4.3.2.2. Напони у бетону

Stresses in concrete

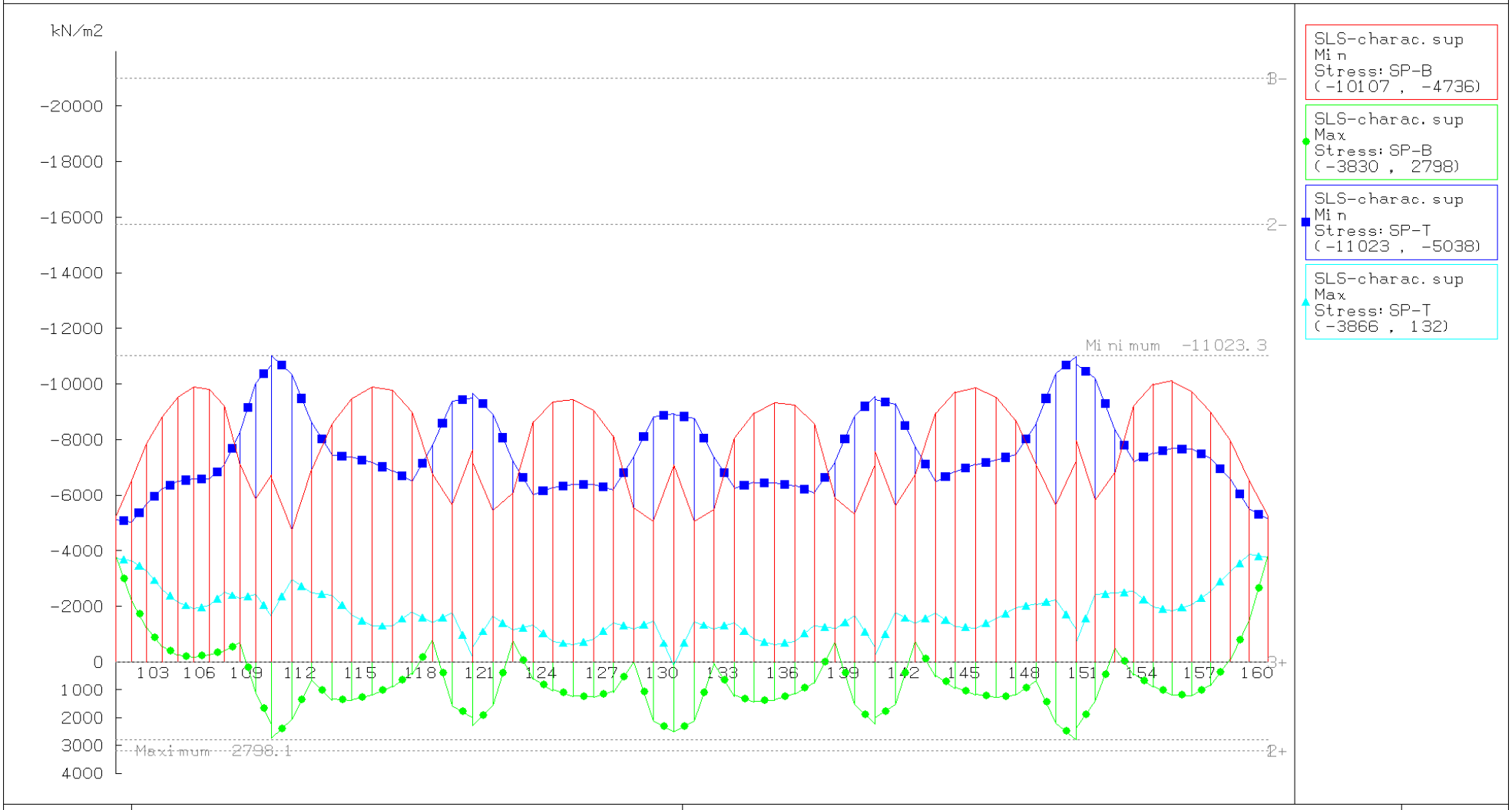
ЛЕГЕНДА /LEGEND:

Stress: SP-T (max/min) - **максимални и минимални напони у горњем влакну** /
Maximum and minimum values at top fiber

Stress: SP-B (max/min) - **максимални и минимални напони у доњем влакну** /
Maximum and minimum values at bottom fiber



Envelope SLS-charac.sup – Combinations 1-7



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Stress Check -Characteristic comb / Bottom and Top Stress Point

RmSet: Charac-MG, Stage: Stress÷check-Pl

1 cm Plot = 1916.8 kN/m2

(DefaultSchedule)/301÷Characteristic÷Stress

0 1916.8 3833.7 5750.5 7667.3 9584.2

01/04/2021
10:04

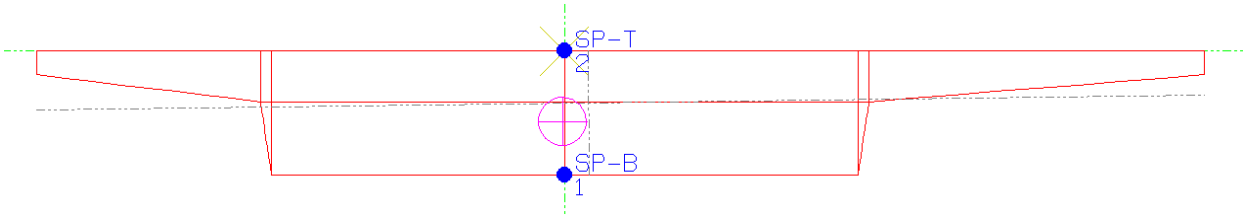
4.3.2.3. Контрола декомпресије

Decompression check

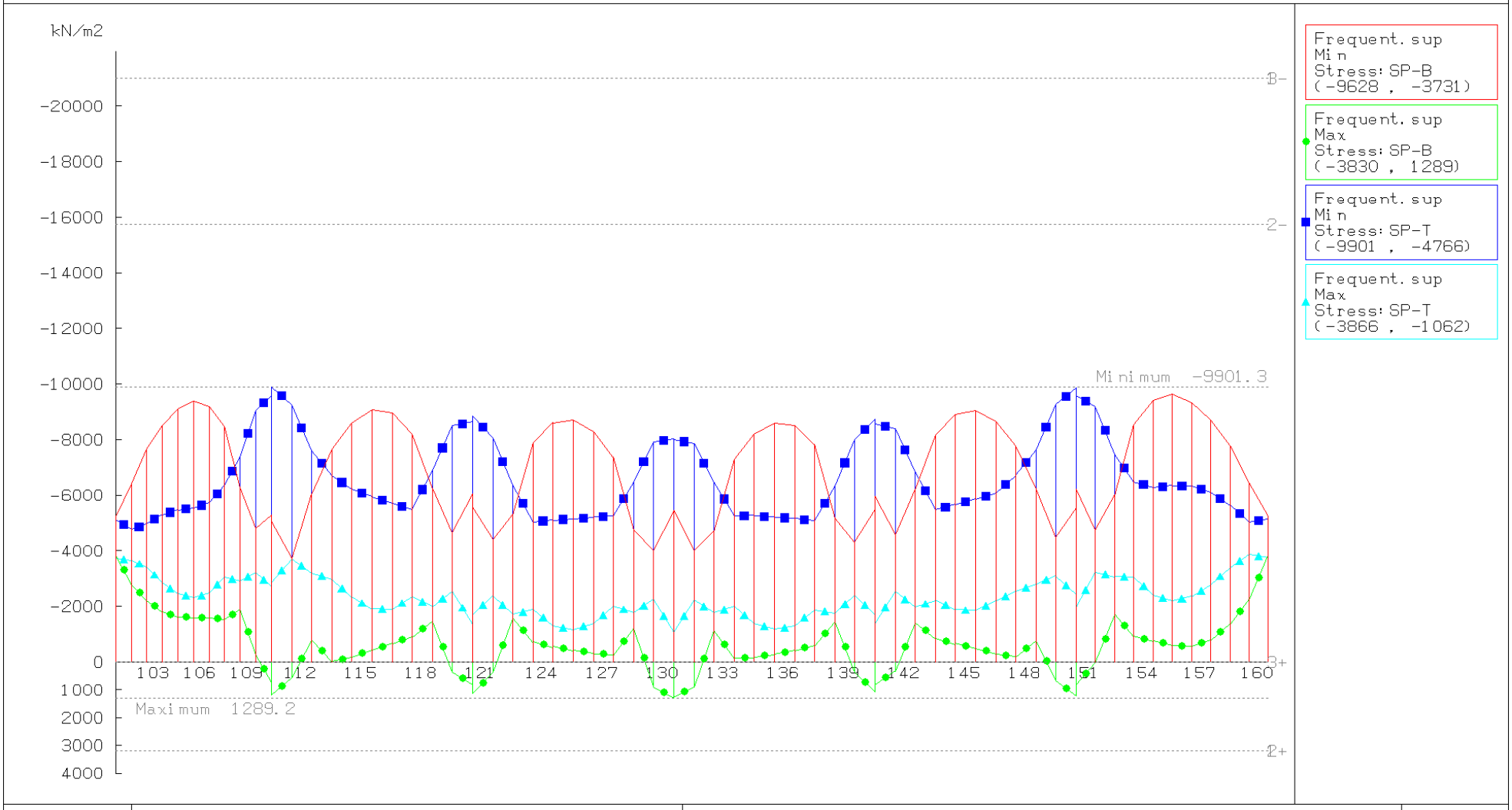
ЛЕГЕНДА /LEGEND:

Stress: SP-T (max/min) - **максимални и минимални напони у горњем влакну** /
Maximum and minimum values at top fiber

Stress: SP-B (max/min) - **максимални и минимални напони у доњем влакну** /
Maximum and minimum values at bottom fiber



Envelope Frequent.sup - Combinations 8-9



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Stress Check -Frequent comb / Left Girder / Bottom and Top Stress Point

RmSet: Frequent-MG, Stage: Stress+check-Pl

(DefaultSchedule)/303+Frequent+Stress

1 cm Plot = 1916.8 kN/m2

0 1916.8 3833.7 5750.5 7667.3 9584.2

01/04/2021
10:04

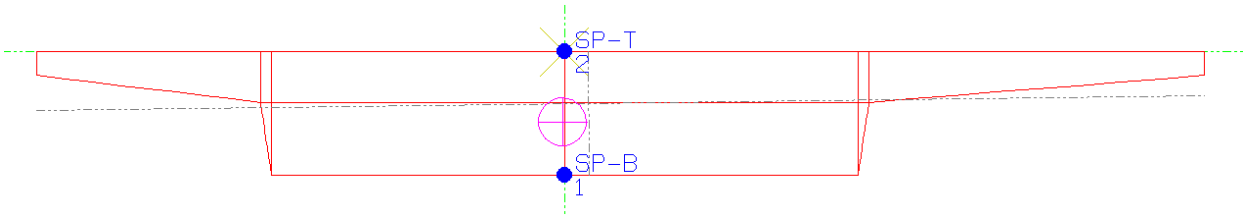
4.3.2.4. Контрола линеарног течења

Creep calculation

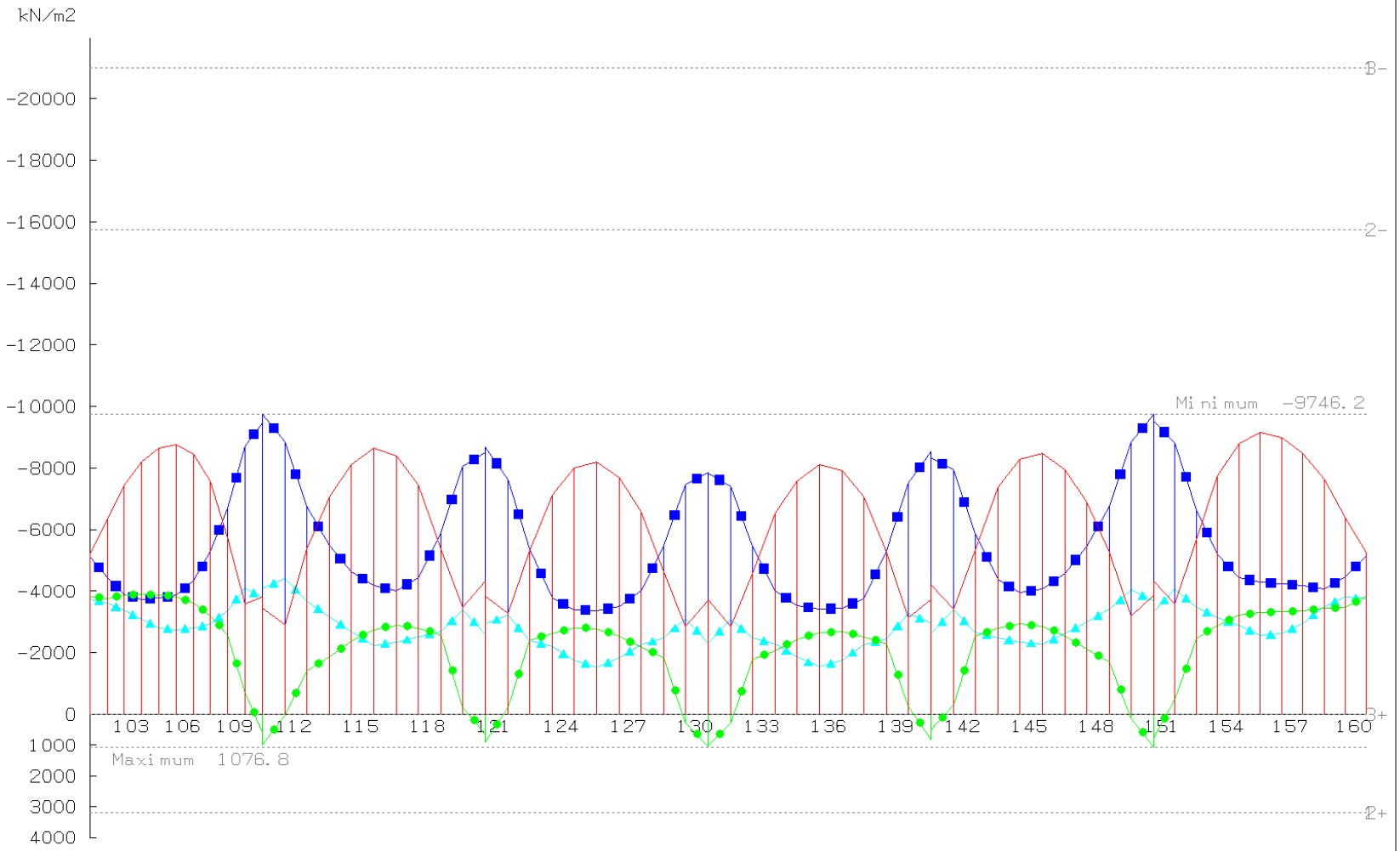
ЛЕГЕНДА /LEGEND:

Stress: SP-T (max/min) - **максимални и минимални напони у горњем влакну** /
Maximum and minimum values at top fiber

Stress: SP-B (max/min) - **максимални и минимални напони у доњем влакну** /
Maximum and minimum values at bottom fiber



Envelope Quasi-perm.sup - Combinations 10-11



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Stress Check - Quasi-perm. comb / Bottom and Top Stress Point

RmSet: Quasi-perm-MG, Stage: Stress÷check-P1

(DefaultSchedule)/302÷Quasi-perm÷Stress

1 cm Plot = 1916.8 kN/m2

0 1916.8 3833.7 5750.5 7667.3 9584.2

01/04/2021
10:04

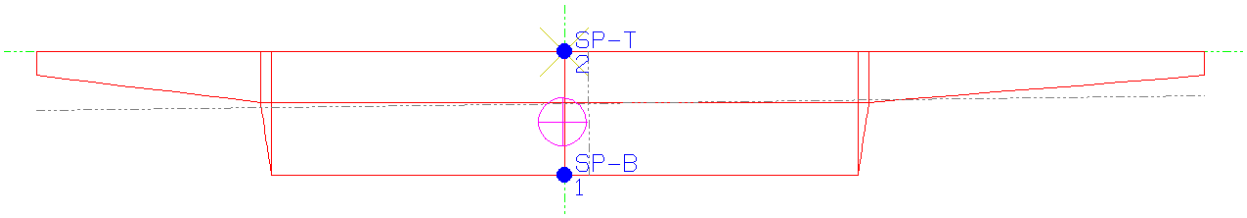
4.3.2.5. Контрола замора

Fatigue limit state

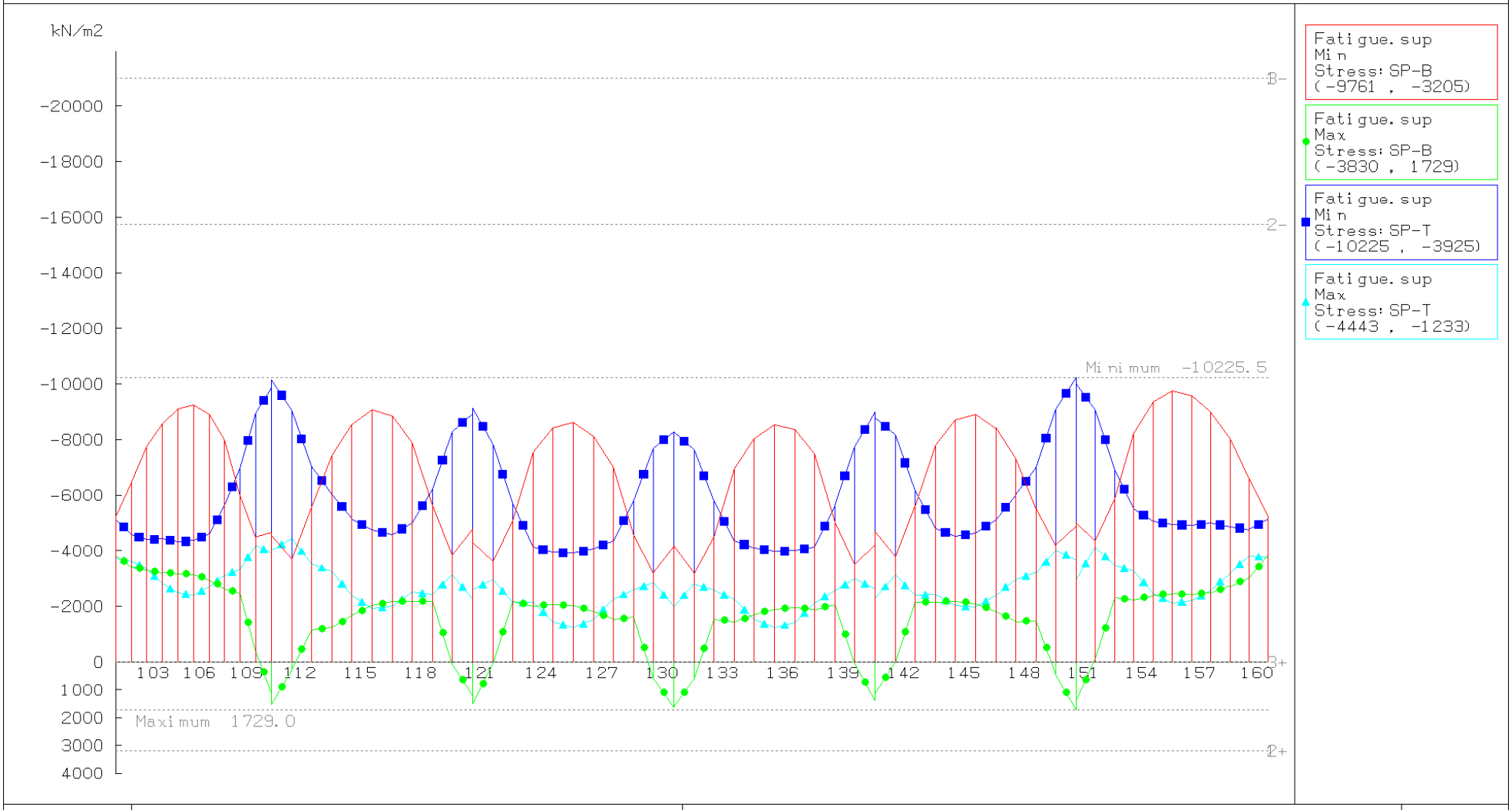
ЛЕГЕНДА /LEGEND:

Stress: SP-T (max/min) - **максимални и минимални напони у горњем влакну** /
Maximum and minimum values at top fiber

Stress: SP-B (max/min) - **максимални и минимални напони у доњем влакну** /
Maximum and minimum values at bottom fiber



Envelope Fatigue.sup - Combinations 10-11 and 18-19



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Stress Check -Characteristic comb / Bottom and Top Stress Point

RmSet: Fatigue-MG, Stage: Stress÷check-P1

1 cm Plot = 1916.8 kN/m2

(DefaultSchedule)/306÷Fatigue-MG

0 1916.8 3833.7 5750.5 7667.3 9584.2

01/04/2021
11:55

Верификација чврстоће на замор при притиску бетона је извршена ако је испуњен следећи услов:/
Fatigue check is satisfied if the following equation states:

$$\frac{\sigma_{c,max}}{f_{cd,fat}} \leq 0.5 + 0.45 \cdot \frac{\sigma_{c,min}}{f_{cd,fat}} \leq 0.9 \; za \; f_{ck} \leq 50 \; MPa$$

$\sigma_{c,max}$ – **највећи напон притиска у неком влакну пресека за честу комбинацију оптерећења са возилом LM3 (притисак је позитиван)/**maximum concrete compressive stress under combination with LM3 load

$\sigma_{c,min}$ – **најмањи напон притиска у истом влакну пресека у којем се појављује $\sigma_{c,max}$/** minimum concrete compressive stress in same fiber

$\beta_{cc}(t0)$ – **коефицијент за чврстоћу бетона при првом оптерећењу** /coefficient for concrete strength when the first load is applied

$$\beta_{cc}(t0) = \exp\{s \cdot \left[1 - (\frac{28}{t})^{1/2}\right]\}$$

Где су /Where:

s – **коефицијент који зависи од типа цемента** /type of cement

t – **старост бетона, у данима** /concrete age in days

$f_{cd,fat}$ – **прорачунска чврстоћа при замору бетона** /design concrete strength for fatigue load

$$f_{cd,fat} = k1 \cdot \beta_{cc}(t0) \cdot f_{cd} \cdot (1 - \frac{f_{ck}}{250})$$

k1=	0.85	
fck=	35.00	MPa
t=	365.00	days
s=	0.25	
αcc=	0.85	
βcc(t0)=	1.20	MPa
fcd= αcc x fck,		
cyl/γc =	19.83	MPa
fcd,fat=	17.37	MPa

Combintions	10	11	18	19
abs(σc)-max(MPa)	9.746	9.071	10.225	9.065
abs(σc)-min(MPa)	4.770	4.095	3.830	3.740
$\sigma_{c\text{-}max}/f_{cd,fat}$	0.561063	0.522204	0.588638	0.521858
$0.5+0.45*\sigma_{c\text{-}min}/f_{cd,fat}$	0.623571	0.606084	0.599219	0.596888

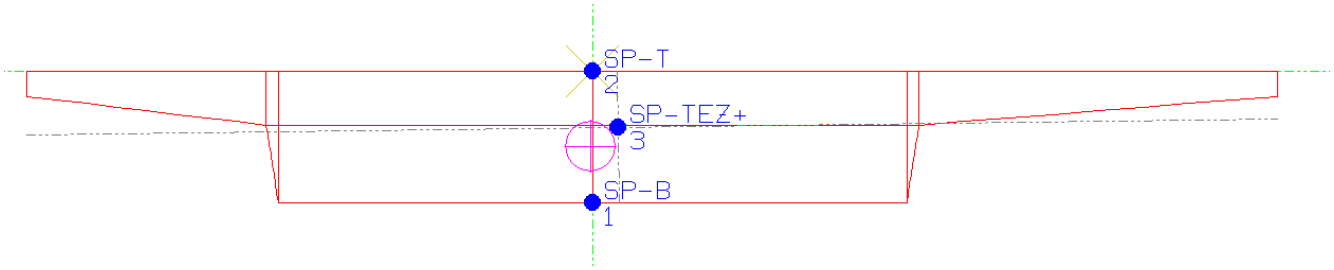
Испуњен је услов контроле замора /Fatigue check is fullfiled.

4.3.2.6. Главни напони

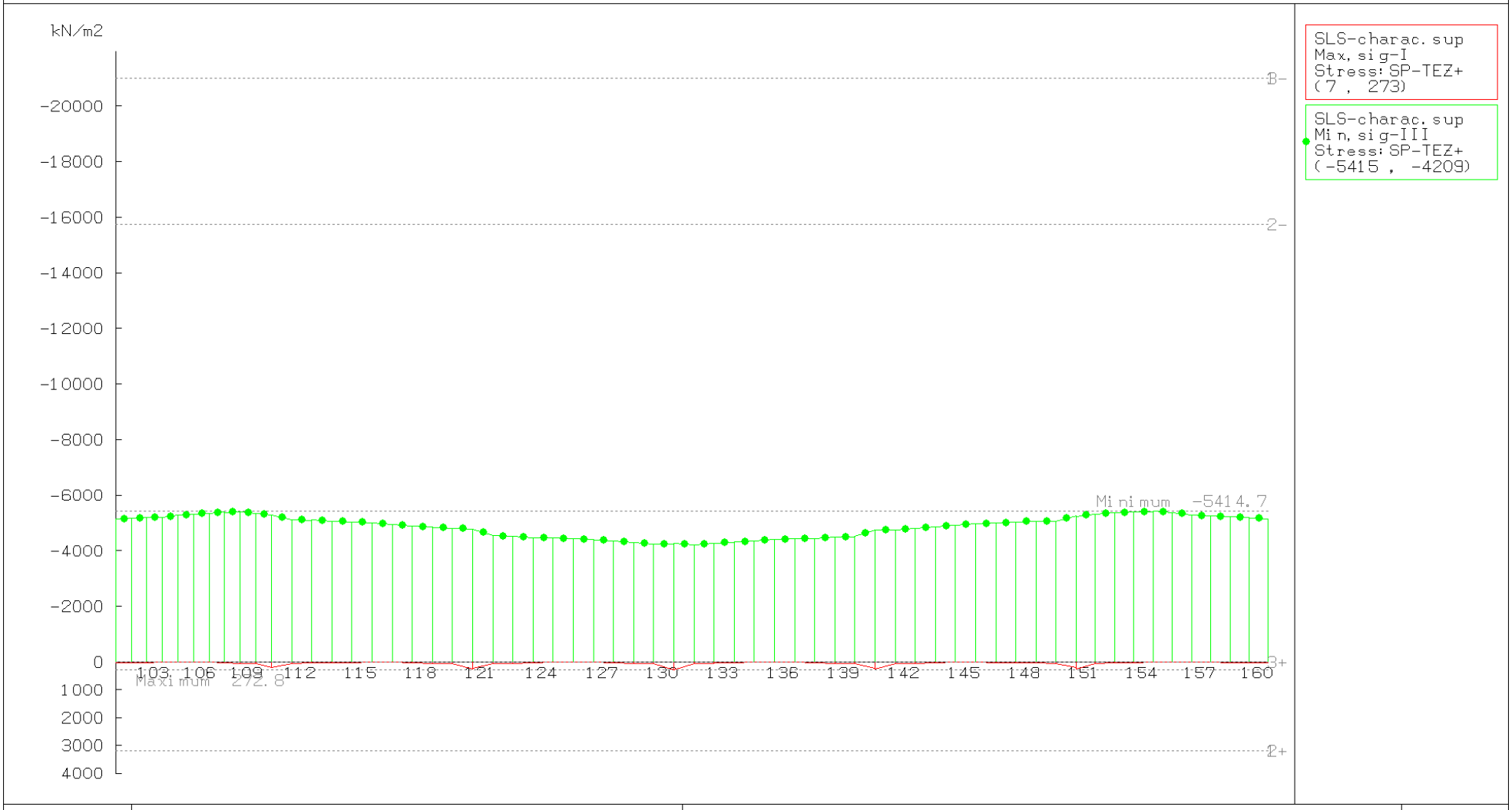
Principle stresses

ЛЕГЕНДА /LEGEND:

Stress: SP-TEZ



Envelope SLS-charac.sup – Combinations 1-7



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Stress Check -Characteristic comb / Bottom and Top Stress Point

RmSet: Charac-MG-Glavni, Stage: Stress÷check-P1

(DefaultSchedule)/307÷Glavni÷naponi

1 cm Plot = 1916.8 kN/m2

0 1916.8 3833.7 5750.5 7667.3 9584.2

01/04/2021
13:15

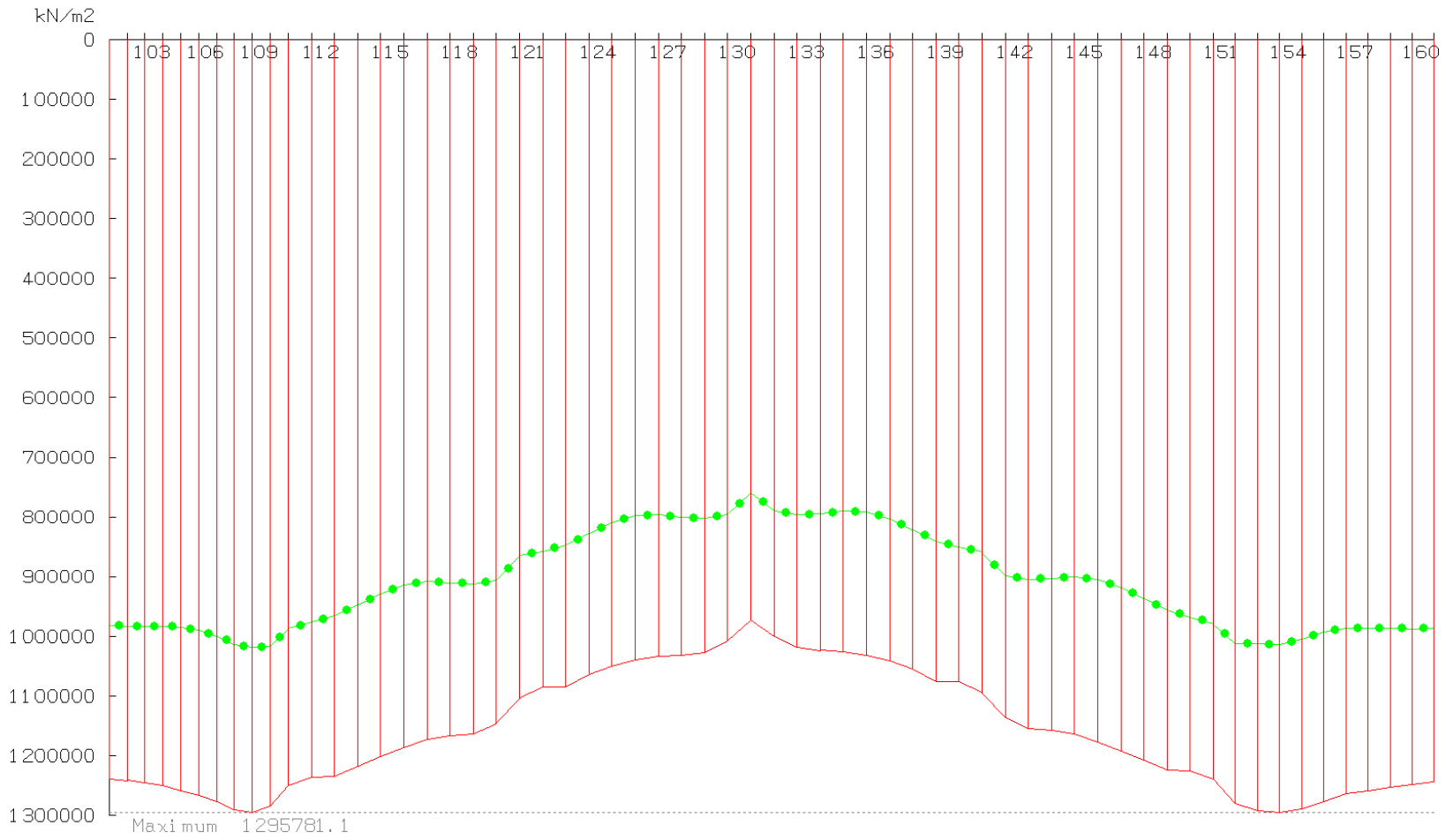
4.3.2.7. Напони у преднапрегнутом челику

Stresses in prestressing steel

Envelope SLS-charac.sup – Combinations 1-7

SLS-charac - σp ≤ 0.75*fpk

fpk= 1860 MPa → 0.75*fpk= 1395 MPa



Charac-Tnds.sup
Max
101
(972402 , 1295781)

Charac-Tnds.sup
Min
101
(760269 , 1019019)

RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Tendon Stress -Quasi-permanent comb

RmSet: Charac-Tend-MG, Stage: Stress÷check-P1

1 cm Plot = 102636.1 kN/m2

(DefaultSchedule)/304÷Napon÷u÷kablovima

0 102636.1 205272.2 307908.4 410544.5 513180.6

01/04/2021
14:06

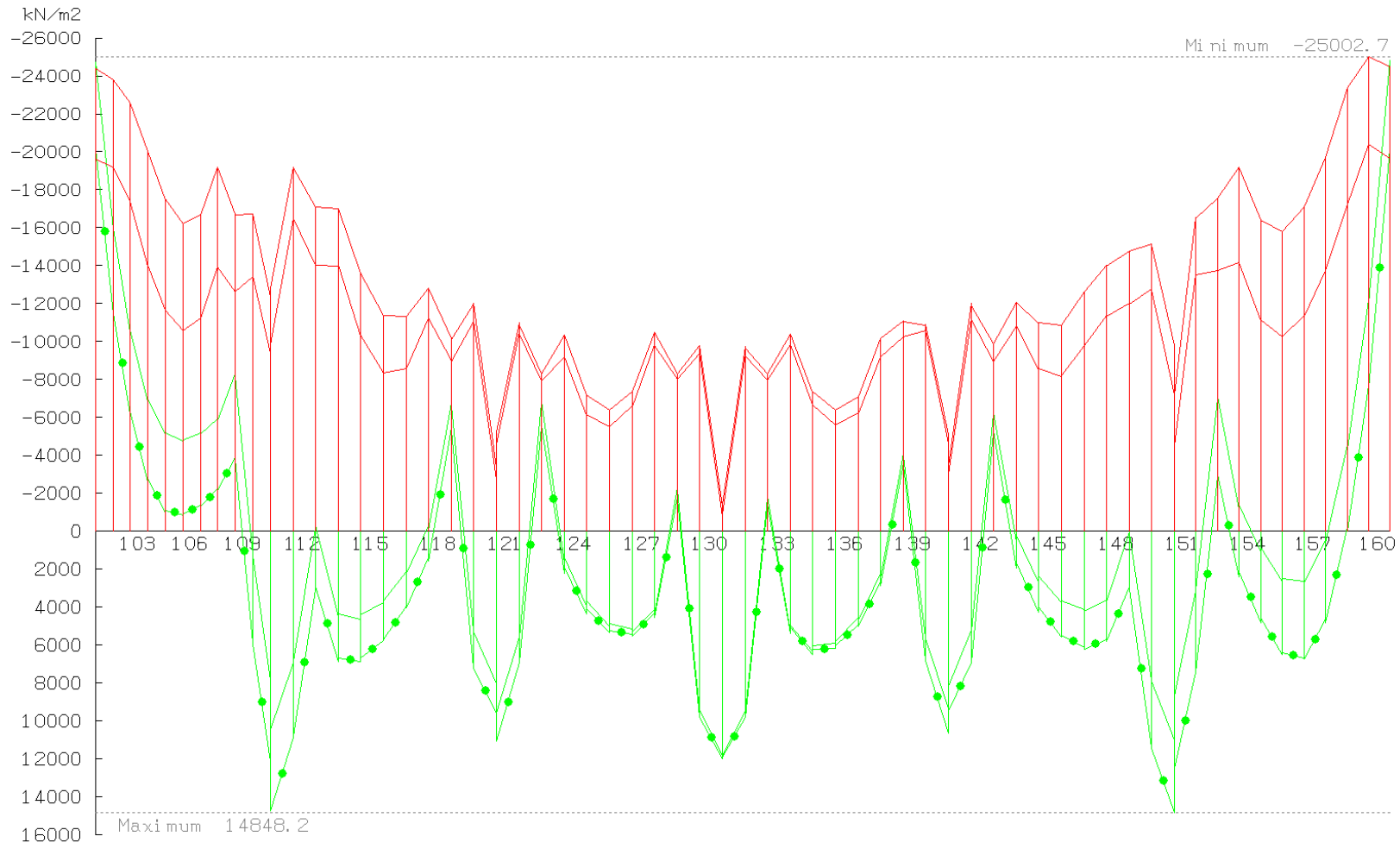
4.3.2.8. Напони у арматурном челику

Stresses in reinforcing steel

Envelope SLS-charac.sup – Combinations 1-7

SLS-charac - σs ≤ 0.8*fyk = 400 MPa

fyk= 500 MPa → 0.8*fyk= 400 MPa



Author: DB Inzenjering , Beograd

Project:

Tendon Stress -Quasi-permanent comb

RmSet: Charac-Reinf-MG, Stage: Stress÷check-P1

1 cm Plot = 3156.5 kN/m2

(DefaultSchedule)/308÷Napon÷u÷armaturi

0 3156.5 6313.0 9469.5 12626.0 15782.5

01/04/2021
14:08

4.3.2.9 Kontrola ugiba

Deflections

Nakon utezanja užadi, očvršćavanja betona nosača i obavljenog skupljanja i tečenja betona irelaksacije čelika

Deflections are checked in stage one, after installation of precast girders. Prestressing deflections after tendon stressing are shown, following deflections after concrete stregthening and deflections as consequance of time deformation effects(creep and shrinkage and steel relaxation).

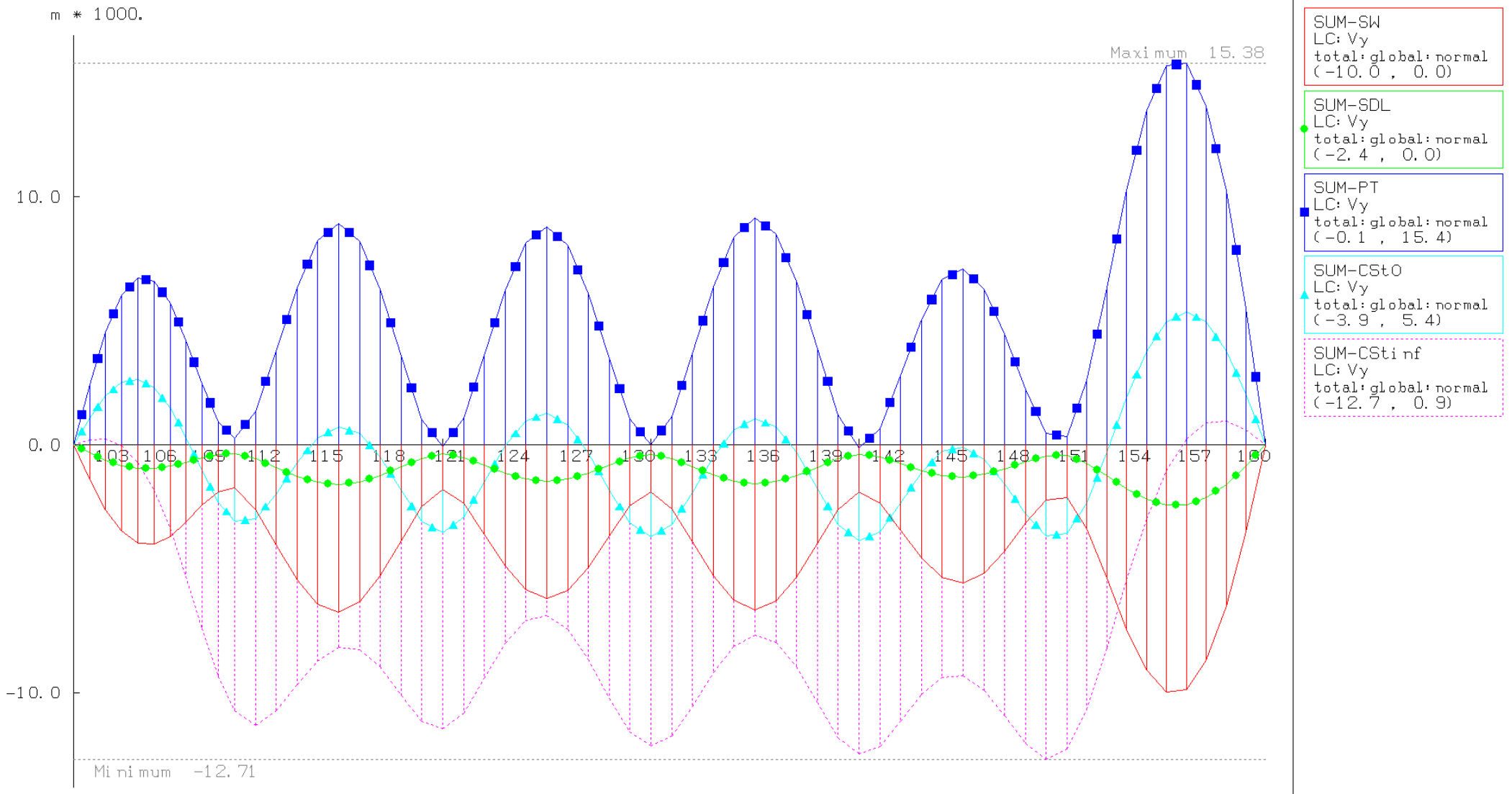
Ознаке на дијаграму / *Graph legend*:
- угиб на доле / *sagging*
+ угиб на горе (одизање) / *lifting*

SW +SDL– угиб од сопствене тежине и додатног сталног оптерећења / *self weight and SDL*
Vy=-10 -2.40=-12.4mm

Girder-CS – угиб од скупљања и течења бетона носача / *creep and shrinkage of precast* main concrete
Vy=-3.9-12.7=-16.6mm

Precast-PT – угиб од утицаја утезања каблова / *presstreing of tendons*
Vy=15.4mm

Comb01 =1.0* Girder-SW +1.0* Girder-CS +1.0* Precast-PT +1.0* Precast-CS
(Vy=-13.6mm)



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Displacements Vx

RmSet: Vy

MG! Vy

1 cm Plot = 0.00223 m

0 0.00223 0.00445 0.00668 0.00890 0.01113

01/04/2021
14:56

4.3.3. КОНТРОЛА ГРАНИЧНОГ СТАЊА НОСИВОСТИ

Analysis at the ultimate limit state

4.3.3.1. Прорачун арматуре у плочи

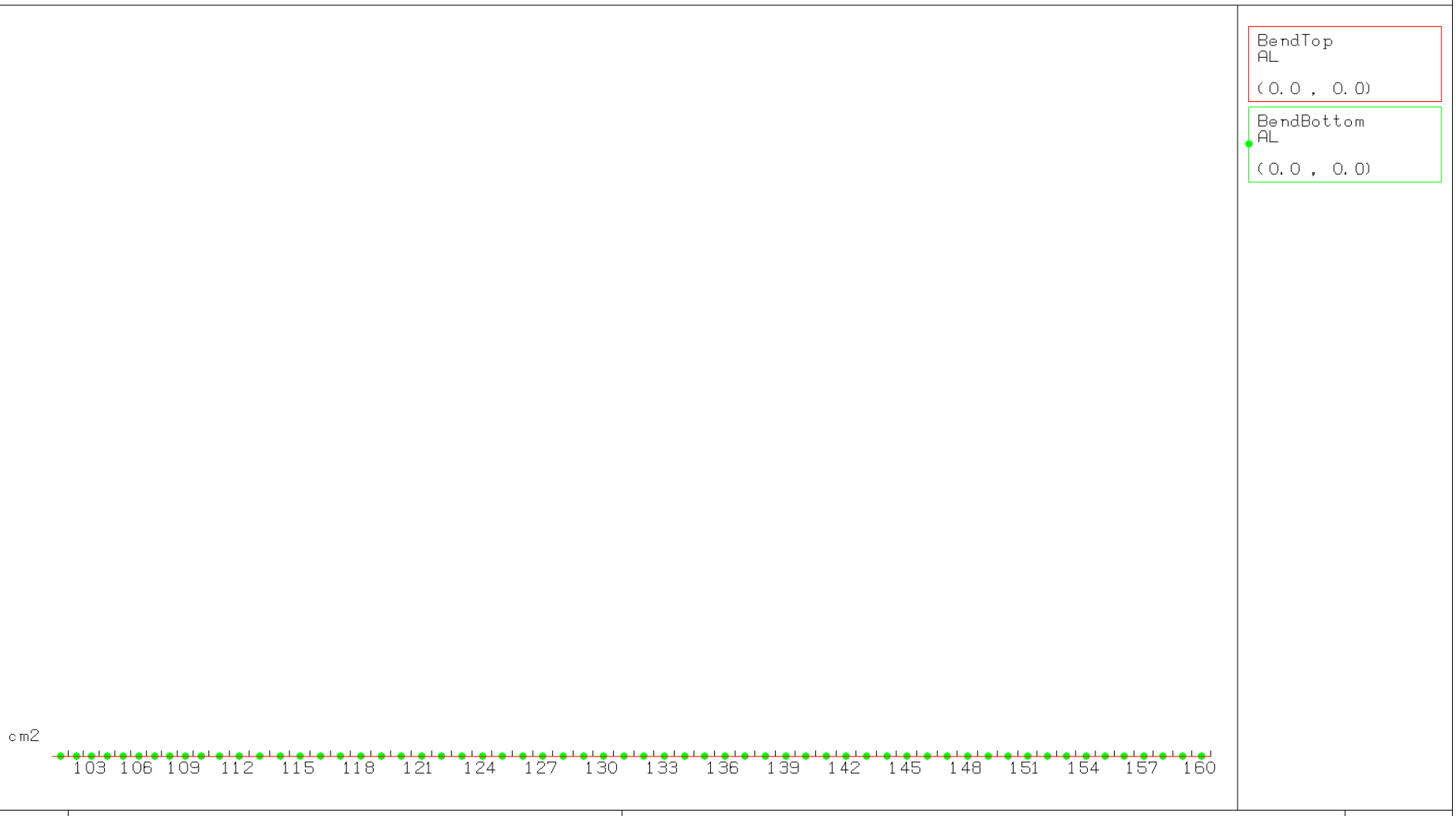
Deck slab reinforcing steel

- BendTop (top), BendBott (bottom)
AL – podužna armatura u ploči usled savijanja /longitudinal reinforcement in deck slab

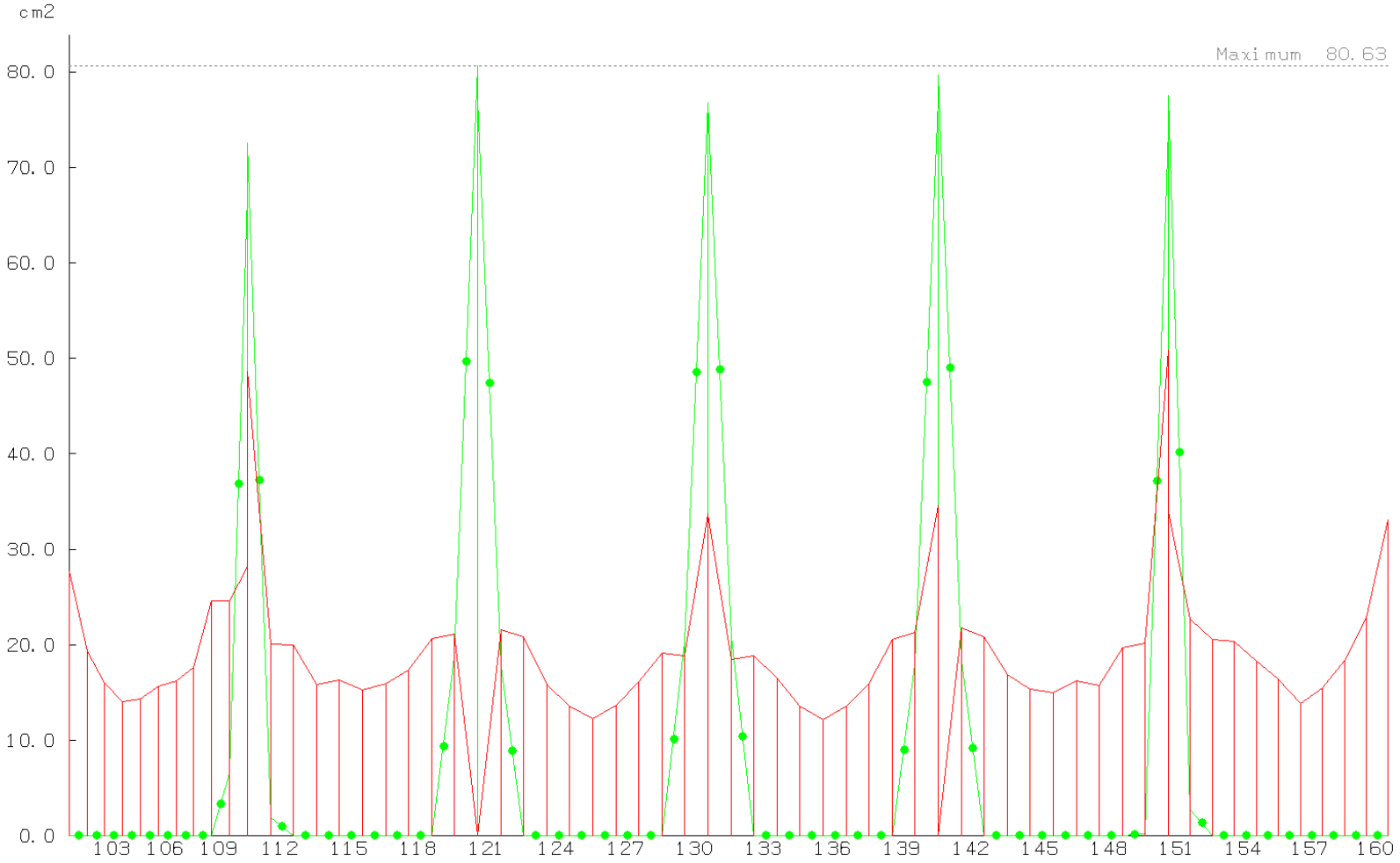
-ShearLong – podužna armatura za smicanje / shear longitudinal reinforcement
AL+M u donjoj zoni ploče / bottom of deck
AL-M u gornjoj zoni ploče / top of deck

- Torsion
AL – podužna armatura od torzije u ploči / torsion longitudinal reinforcement in deck slab

- ShearWeb
AVQ - uzengije od smicanja / stirrups from shear
AVQT - uzengije od smicanja+ torzija / stirrups from interaction shear+torsiontosion



RM Bridge Advanced CONNECT Edition 10.01.00.02	Author: DB Inzenjering , Beograd Project:	Bending Reinforcement RmSet: MG-MinReinf, Stage: Reinforcement-Pl 1 cm Plot = 0.00377 cm2 (DefaultSchedule)/501+Bending+reinforcement+MG 0 0.00377 0.00753 0.01130 0.01507 0.01884	01/04/2021 13:15



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Longitudinal Shear Reinforcement

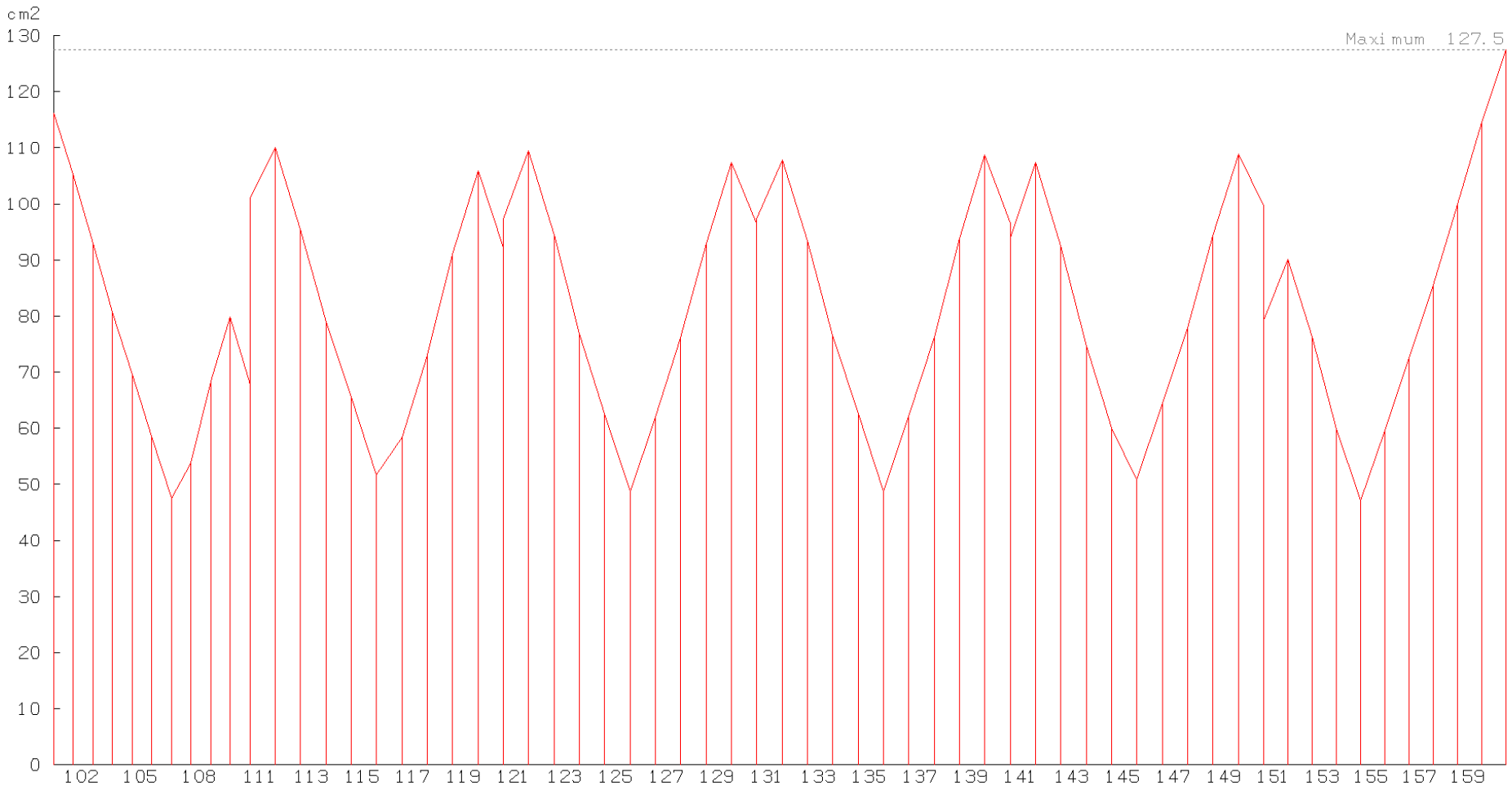
RmSet: MG-ShearLong, Stage: Reinforcement-Pl

(DefaultSchedule)/502+Shear+Long

1 cm Plot = 6.386 cm2

0 6.386 12.772 19.159 25.545 31.931

01/04/2021
13:15



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

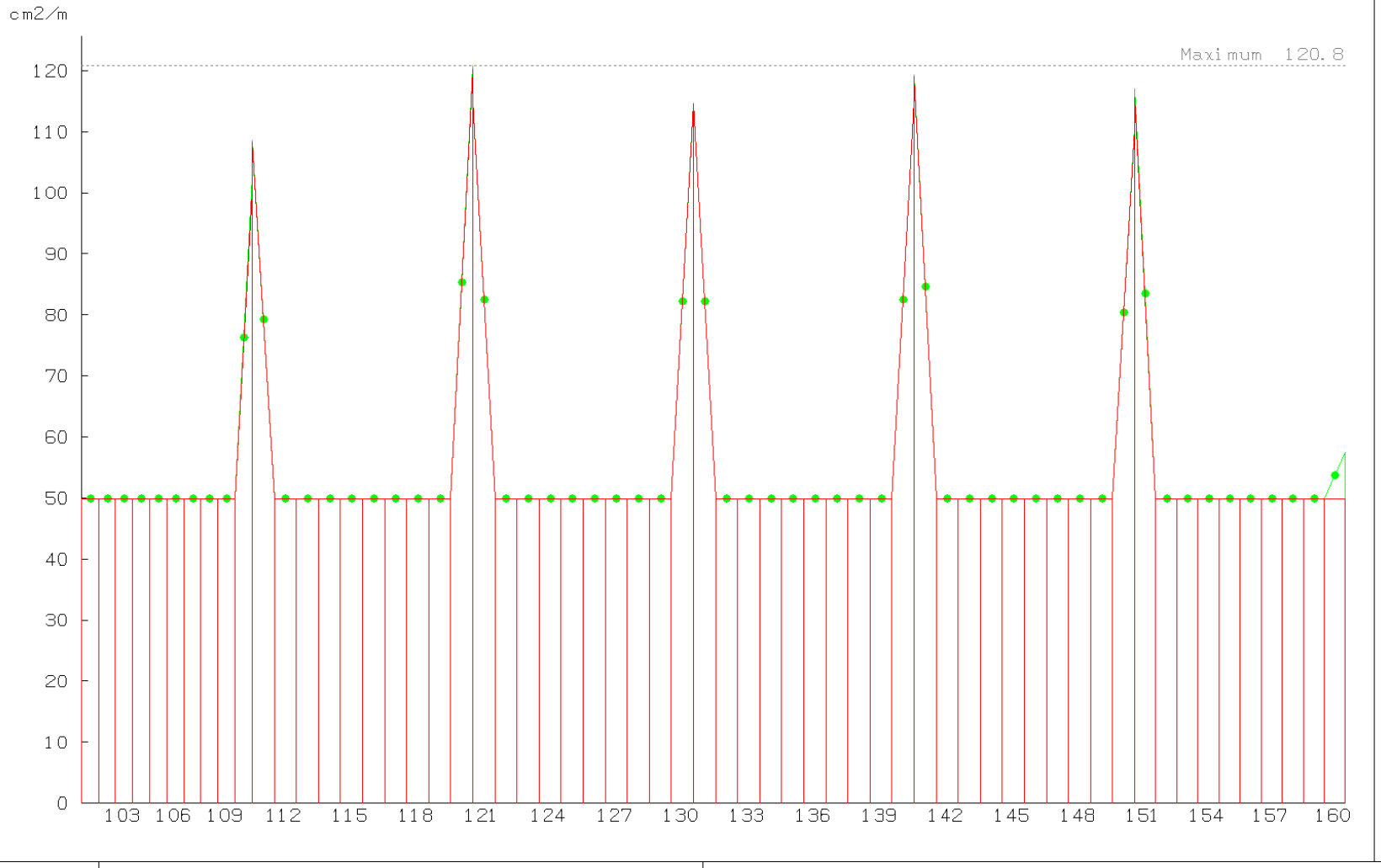
Torsional Reinforcement
Reinforcement group: Torsion ALT
RmSet: MG-TorsLong, Stage: Reinforcement-Pl, Attribute set: Torsion

1 cm Plot = 10.10 cm2

0 10.10 20.19 30.29 40.39 50.49

(DefaultSchedule)/503÷Tors÷Long

01/04/2021
13:15



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Shear reinforcement for web

RmSet: MG-ShWebStirrup, Stage: Reinforcement-P1

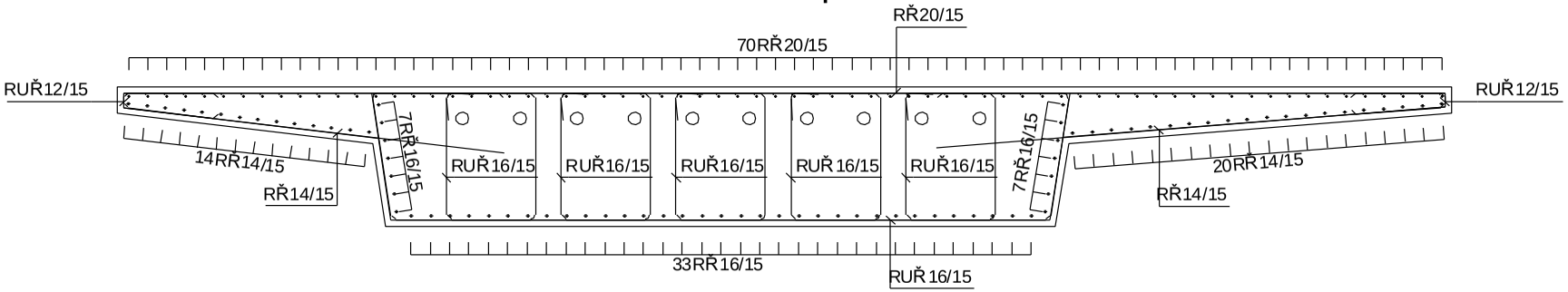
(DefaultSchedule)/504+Shear+Tors+WebStirrup

1 cm Plot = 9.571 cm2/m

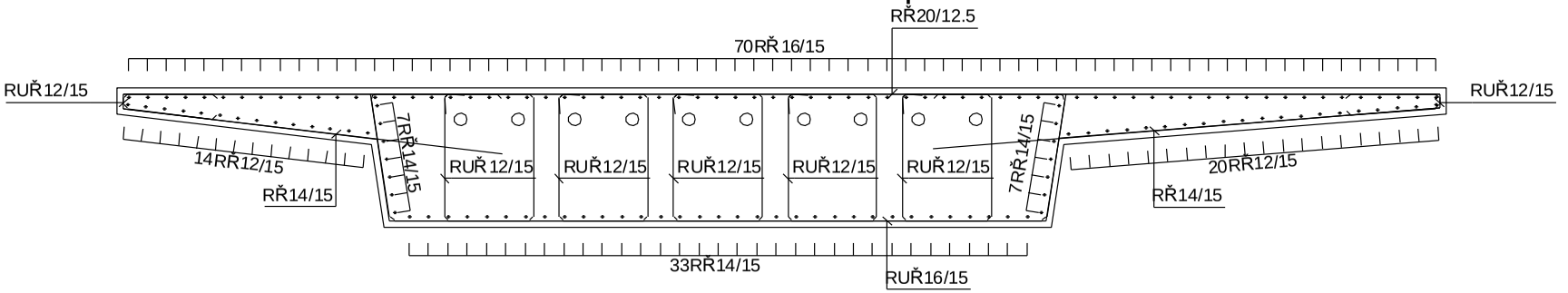
0 9.571 19.142 28.713 38.284 47.854

01/04/2021
13:15

Presek nad srednjim stubom
Cross section at pier



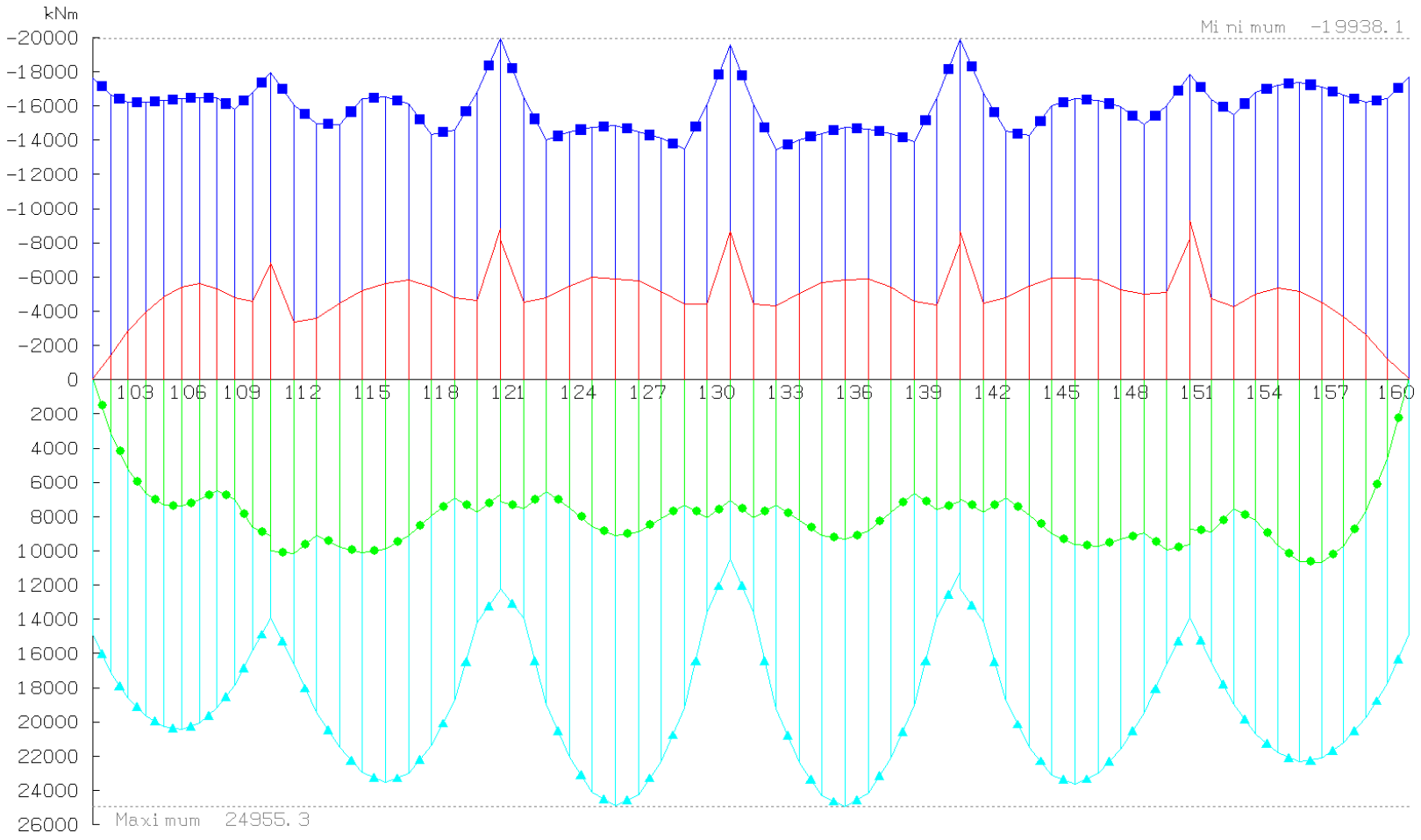
Presek u sredini polja
Cross section at middle of span



4.3.3.2. Носивост пресека – момент лома

Moment capacity at the ultimate limit state

ULS – Proračunska vrednost momenta savijanja / Design value of the applied internal bending moment
ULT-ULS - Moment nosivosti preseka / Resistent moment of cross section



ULS.sup
MinMz: Mz
total: local: normal
(-9319 , -73)

ULS.sup
MaxMz: Mz
total: local: normal
(-65 , 10695)

ULT-ULS.sup
MinMz: Mz
total: local: normal
(-19938 , -13449)

ULT-ULS.sup
MaxMz: Mz
total: local: normal
(10451 , 24955)

RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Ultimative Cross Section Capacity

RmSet: ULS-ULT-Mz-MG, Stage: ULT-P1

(DefaultSchedule)/601÷ULT

1 cm Plot = 3555.9 kNm

0 3555.9 7111.8 10667.8 14223.7 17779.6

01/04/2021
13:15

4.4. ДИМЕНЗИОНИСАЊЕ ЛЕЖИШТА И ДИЛАТАЦИЈЕ

Design bearings and expansion joints

4.4.1. АНАЛИЗА И ДИМЕНЗИОНИСАЊЕ ЛЕЖИШТА

BEARING ANALYSIS AND DESIGN

4.3.4 АНАЛИЗА И ДИМЕНЗИОНИСАЊЕ ЛЕЖИШТА

BEARING ANALYSIS AND DESIGN

Контрола носивости / Load capacity check

Kombinacije opterećenja / Load combinations :

Comb1 → Доминантно возило / Dominant live load

Σ = 1.35(G+dG) + 1.0Sk + 1.35Ts + 1.35UDL +1.35K+0.9W

Comb2 → Доминантна температура / Dominant temperature load

Σ = 1.35(G+dG) + 1.0Sk + 1.01Ts + 0,54UDL +0,54K+1.5W + 1.5T

Comb3 → Доминантна сеизмика / Dominant seizmic load

Σ = 1.0(G+dG) + 1.0Sk + 1.0(20%)UDL +1.0Si+0.3Sik

Opterećenje Load case		Vertikalne reakcie / Vertical reactions Element 1702	Horizontalne reakcie / Horizontal reactions 1702
Sopstvena zežina Self weight	max min	-893 -893	
Dodatno stalno opt. SDL	max min	-367 -367	
Skupljanje Creep	max min	18 18	
LM1-TS	max min	45 -584	
LM1-UDL	max min	31 -285	
Pešaci Pedestrian	max min	20 -123	
Kočenje Brake	max min	11 -11	
Temperatura Temp.	max min	66 -101	
Vetar Wind	max min	17.28 -18.34	-40 40
Seizmika Earthquake	max min	76 -76	-220 220

Comb1	ULS(max)	-1118	-36
	ULS(min)	-3054	36
Comb2	ULS(max)	-1051	-60
	ULS(min)	-2678	60
Comb3	ULS(max)	-1160	-220
	ULS(min)	-1375	220

Horizontalno pom. Horizontal disp.

Opterećenje

Load case	1702
Skupljanje Creep	18
Kočenje	17.6
Brake	-17.6
Temperatura +54 Temp. +54	-35
Temperatura -51 Temp. -51	33
Seizmika	29
Earthquake	-29
Comb1	85
	-70
Comb2	78
	-61

Nmax = 3054kN → **максимано вертикално оптерећење /** maximal vertical load

Nmin = 1118 kN → **минимално вертикално оптерећење /** minimal vertical load

Vx = 220 kN → **максимално хоризонтално оптерећење /** maximal horizontal load

U = ±85mm → **максимално хоризонтално померање /** maximal horizontal movement

Усвојено лончасто лежиште / Require pot bearing

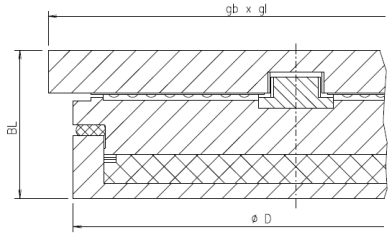
Подужно померљиво / longitudinal guided

Nd = 3600 kN >3054 kN

Vx,d = 330 kN > 121 kN

Ud = ±85 mm

Navođeno klizno ležište



Longitudinal axis of bridge

4.4.2. ДИЛАТАЦИЈЕ

Expansion joints

N^{o}	OPTEREĆENJE	S1	S7
	LOAD	u [mm]	u [mm]
1	TEMP. t = +54^{0}	-33.1	34.2
2	TEMP. t = -51^{0}	31.1	-33.3
3	SKUPLJANJE / CREEP	18.0	-18.0
A	Umin = 2 + 1.3x3	**54.5**	**-56.7**
	Umax = 1	**-33.1**	**34.2**
4	TEMP. t = +34^{0}	-20.8	21.5
5	TEMP. t = -31^{0}	19.0	-20.3
6	SEIZMIKA ±SX	29.0	29.0
		-29.0	-29.0
B	Umin =(qx6) + 0.5*(0.4*5) +3	**53.2**	**-53.7**
	Umax = (qx6) + 0.5*(0.4*4)	**-35.6**	**35.8**

q = 1.0

A Osnovno opterećenje
B Seizmika - nekritični elementi

Usvojena dilatacija/Provided expansion joint:

D±85mm kod obalnih stubova/at abutments
D±170mm kod srednjeg stuba/at pier

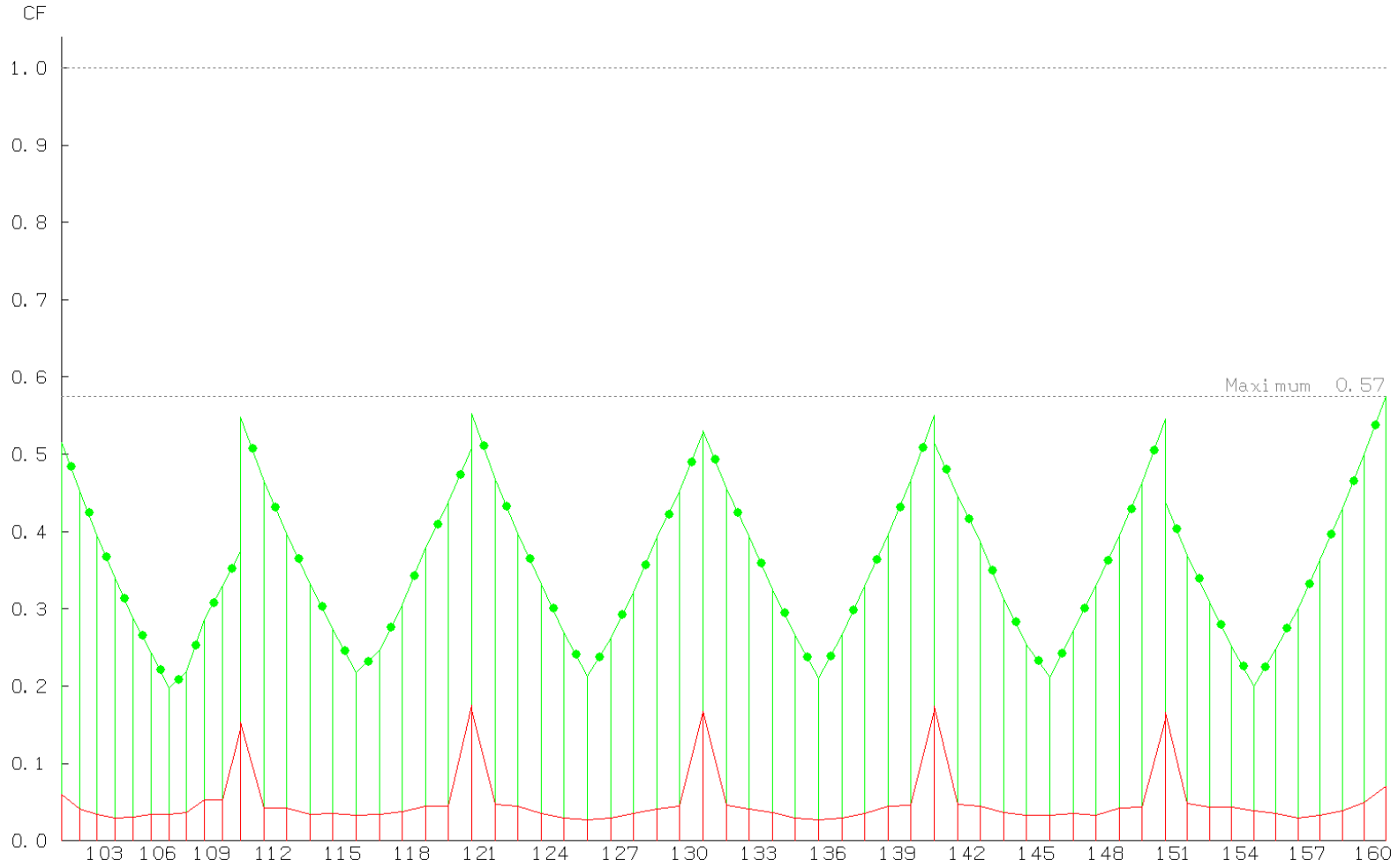
4.5. АНАЛИЗА СУПЕРСТРУКТУРЕ – ПОПРЕЧНИ ПРАВАЦ

SUPERSTRUCTURE ANALYSIS – TRANSVERSE DIRECTION

4.5.1. ПРОРАЧУН НОСИВОСТИ КОЛОВОЗНЕ ПЛОЧЕ

DECK SLAB CAPACITY

- ShearWeb
CFQ - kapacitet nosivosti na smicanje / capacity factor shear
CFQT -kapacitet nosivosti na smicanje+torzija / capacity factor shear+tosion



RM Bridge Advanced CONNECT Edition
10.01.00.02

Author: DB Inzenjering , Beograd

Project:

Shear reinforcement capacity

RmSet: MG-Shear, Stage: Reinforcement-Pl

(DefaultSchedule)/505÷Shear÷Reinf÷Capacity

1 cm Plot = 0.0792 CF

0 0.0792 0.1584 0.2376 0.3168 0.3960

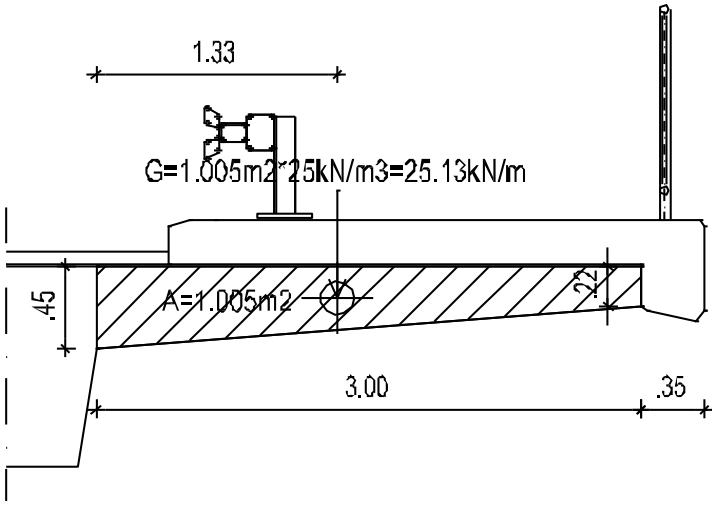
03/04/2021
21:51

4.5.2. ПРОРАЧУН НОСИВОСТИ КОНЗОЛЕ

CAPACITY OF CANTILEVER

4.5.2 Proračun nosivosti konzole / Capacity of cantilever

Sopstvena težina/self weight:

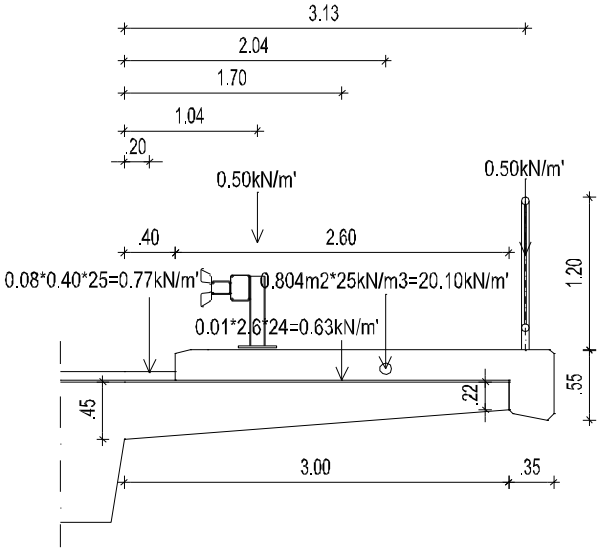


G=25.3kN/mx1m

T=25.3kN

M=25.3*1.33=33.65kNm

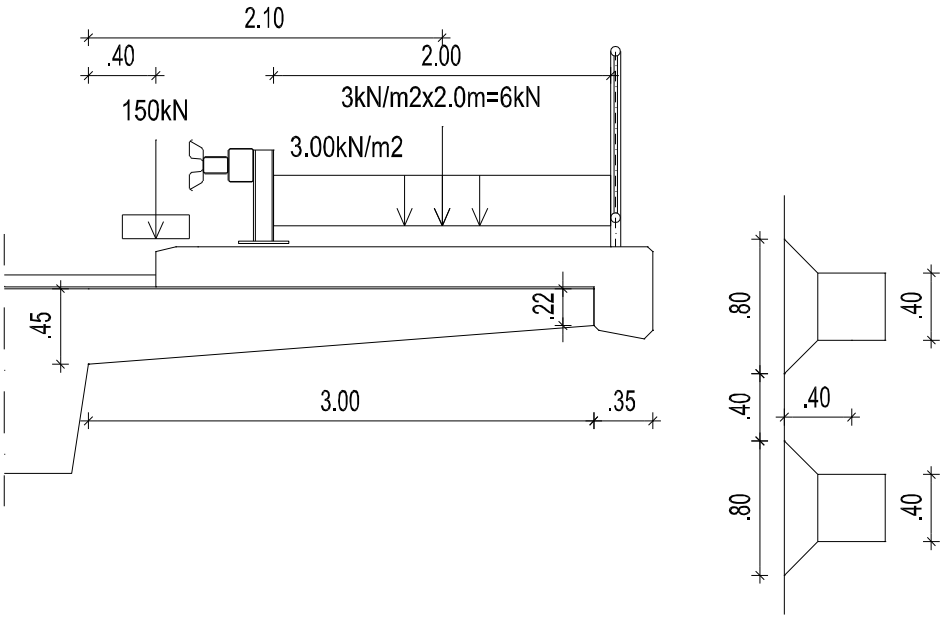
Dodatno stalno/superimposed dead load:



T=(0.77+0.5+0.63+20.1+0.5)kN/mx1m=22.5kN

M=0.77*0.20+0.5*1.04+0.63*1.70+20.10*2.04+0.5*3.13=44.35kNm

Pokretno opterećenje/live load:



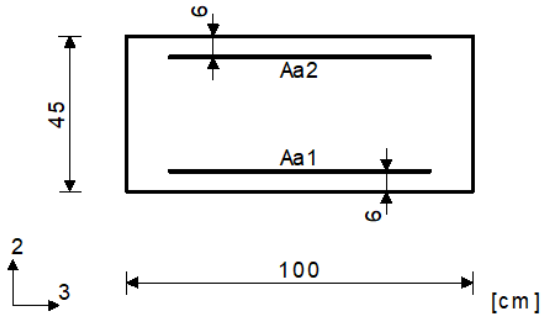
T=150+6=156kN

M=150*0.4/0.80+6*2.10=87.6kNm

Tu=1.35x(25.3+22.5+156)=276kN

Mu=1.35x(33.65+44.35+87.6)=224kNm

SRPS EN 1992-1-1
α,cc = 0.85
C30/37 (γC = 1.50, γS = 1.15) [SP]
B500B



M3ed = 224.00 kNm
V2ed = 276.00 kN

Vrd,max,2 = 1575.29 kN
εb/εa = -3.238/25.000 ‰
Aa1 = 13.85 cm²
Aa2 = 0.00 cm²
Aa3 = 0.00 cm²
Aa4 = 0.00 cm²
Aa,uz = 9.04 cm²/m (m=2)

Usvojena armatura / provided reinforcement :

Gornja zona / Upper side → Aa2 → Φ16/12.5 → Aa1 = 16.08 cm2

Donja zona / Bottom side → Aa1 → 0.50 x 16.08= 8.04 cm2 → Φ14/15 → Aa1 = 10.26 cm2

Podužna/ Longitudinal → Aa3,4 → ±0.35 x 16.08 = 5.63 cm2 → ±Φ12/15 → Aa1 = 7.54

4.6. ANALIZA SUBSTRUKTURE

SUBSTRUCTURE ANALYSIS

S1-S6

4.6.1 Анализа оптерецења / Load analyses

Размарана су следећа оптерећења / The following loads were considered :

- **G – Сопствена тежина /** Self weight
- **dG – Додатно стално оптерећење /** Superimposed load
- **Sk – Скупљање /** Creep
- **TS - Двоосовински тандем систем концентрисаних сила /** Tandem system
- **UDL - једнакоподељено површинско оптерећење /** uniformly distributed load
- **K – Силе кочења /** Braking forces
- **T – Температурна промена** / Uniform temperature change
- **dT – Температурна разлика** / Linear temperature change
- **W – Ветар** / wind
- **Sx,y,z – Сеизмика /** Seizmic load

Kombinacije opterećenja / Load combinations :

Comb1 → Доминантно возило / Dominant live load

$$\sum = 1.35(G+dG) + 1.0Sk + 1.35Ts + 1.35UDL + 1.35K + 0.9W$$

Comb2 → Доминантна температура / Dominant temperature load

$$\sum = 1.35(G+dG) + 1.0Sk + 1.01Ts + 0{,}54UDL + 0{,}54K + 1.5W + 1.5T$$

Comb3 → Доминантна сеизмика / Dominant seizmic load

$$\sum = 1.0(G+dG) + 1.0Sk + 1.0(20\%)UDL + 1.0Si + 0.3Sik$$

4.6.2 **Стубови /** Piers

4.6.2.1 **Модална анализа /** Modal analyses

Load factors for mass calculations

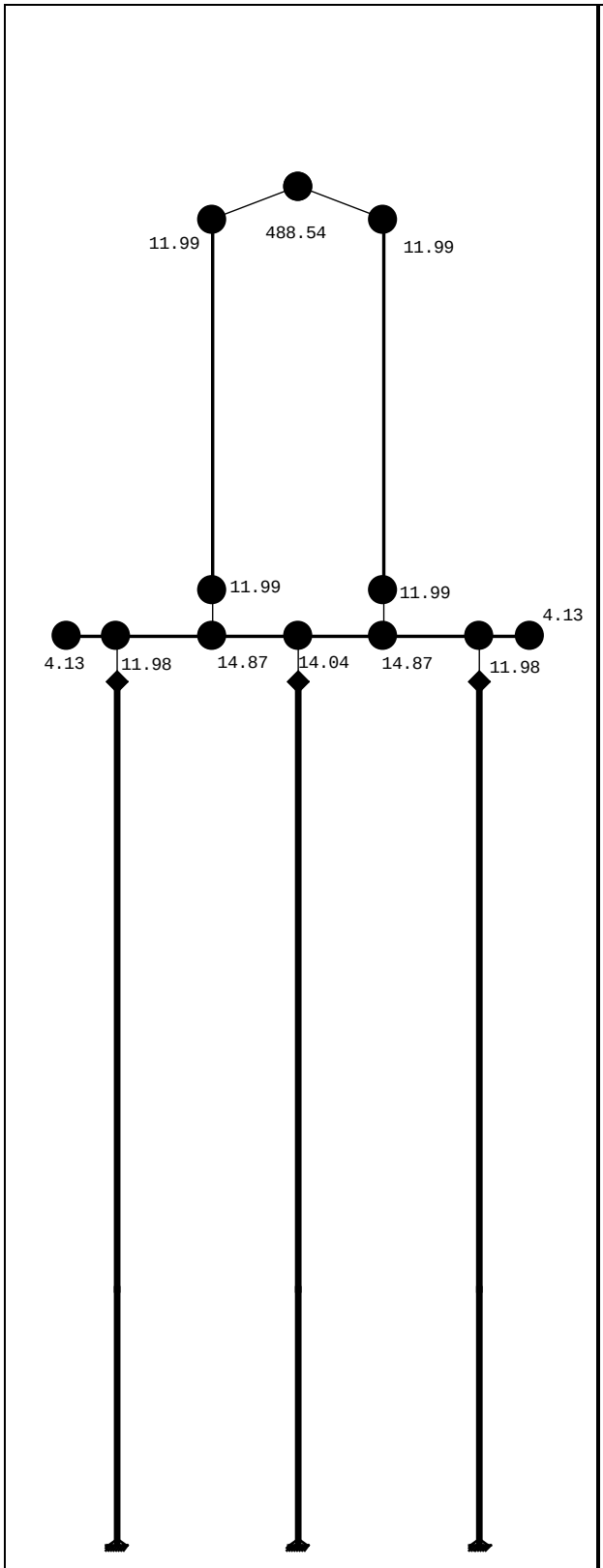
No	Name	Factor
1	Sopostvena tezina (g)	1.00
2	Dodatno stalno	1.00
3	UDL (20%)	1.00
4	Skupljanje	0.00
5	TS	0.00
6	UDL	0.00
7	Kocenje	0.00
8	T+34	0.00
9	T-31	0.00
10	dt+12.3	0.00
11	dt-8	0.00
12	Vetar	0.00

Mass distribution per levels

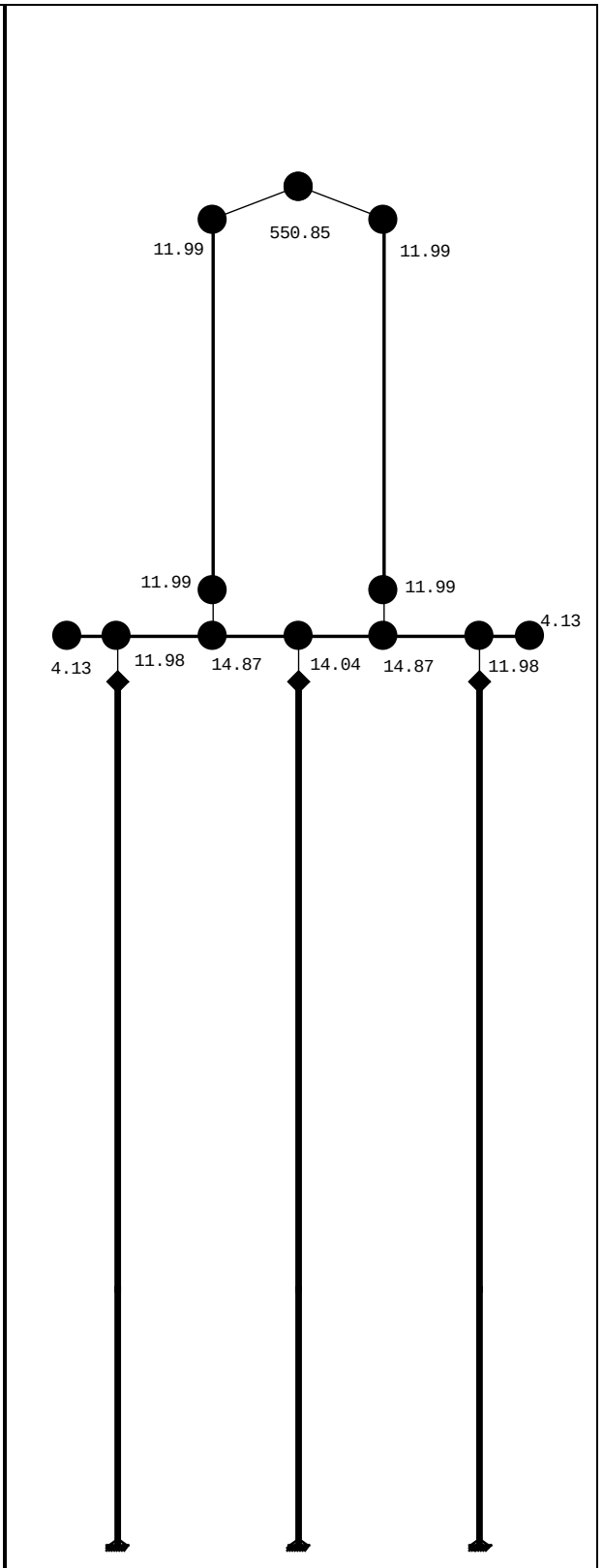
Level	Z [m]	X [m]	Y [m]	Mass [T]	T/m²
	0.00	35.12	-8.64	3776.15	
Total:	0.00	35.12	-8.64	3776.15	

Natural frequency of structure

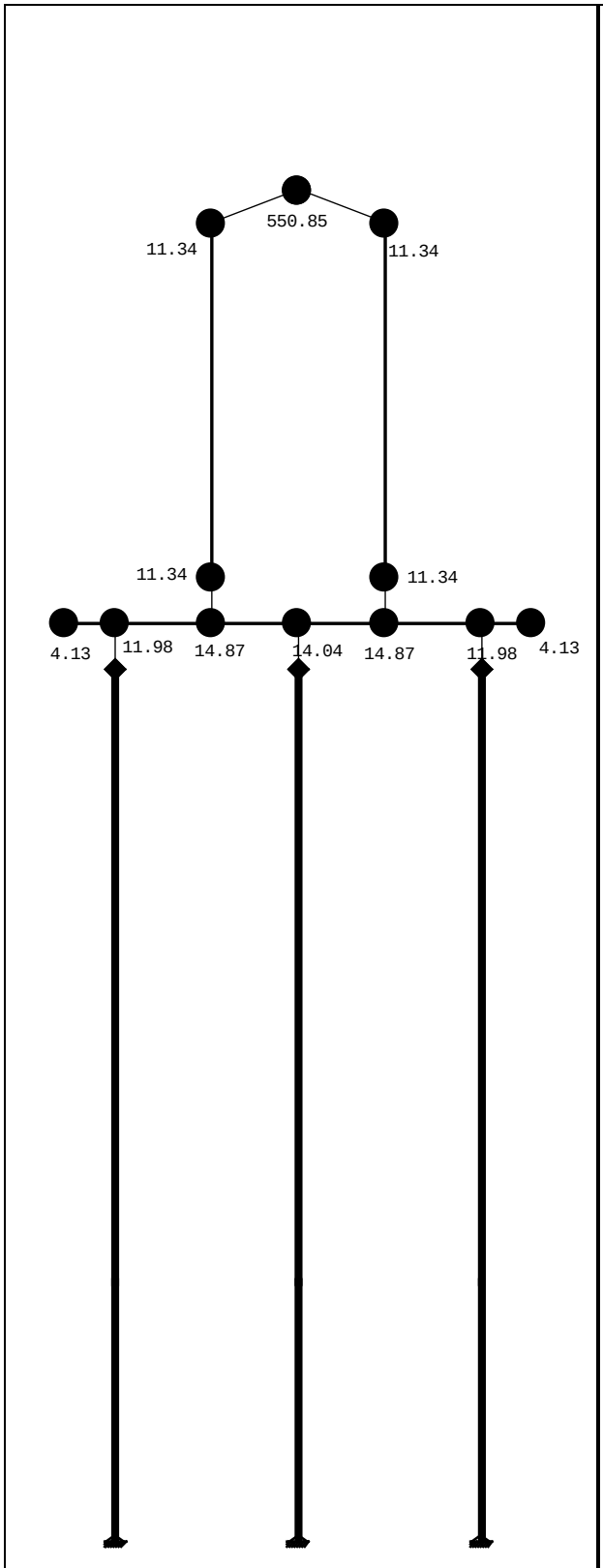
No	T [s]	f [Hz]
1	**1.1233**	**0.8902**
2	**0.6195**	**1.6141**
3	0.3191	3.1334
4	0.1703	5.8716
5	0.1480	6.7583
6	0.1405	7.1189
7	0.1391	7.1888
8	0.1374	7.2786
9	0.1321	7.5721
10	0.1315	7.6035
11	**0.1265**	**7.9077**
12	0.1258	7.9507
13	0.1247	8.0212
14	0.1232	8.1186
15	0.1201	8.3295
16	0.1190	8.4032
17	0.1161	8.6104
18	0.1155	8.6590



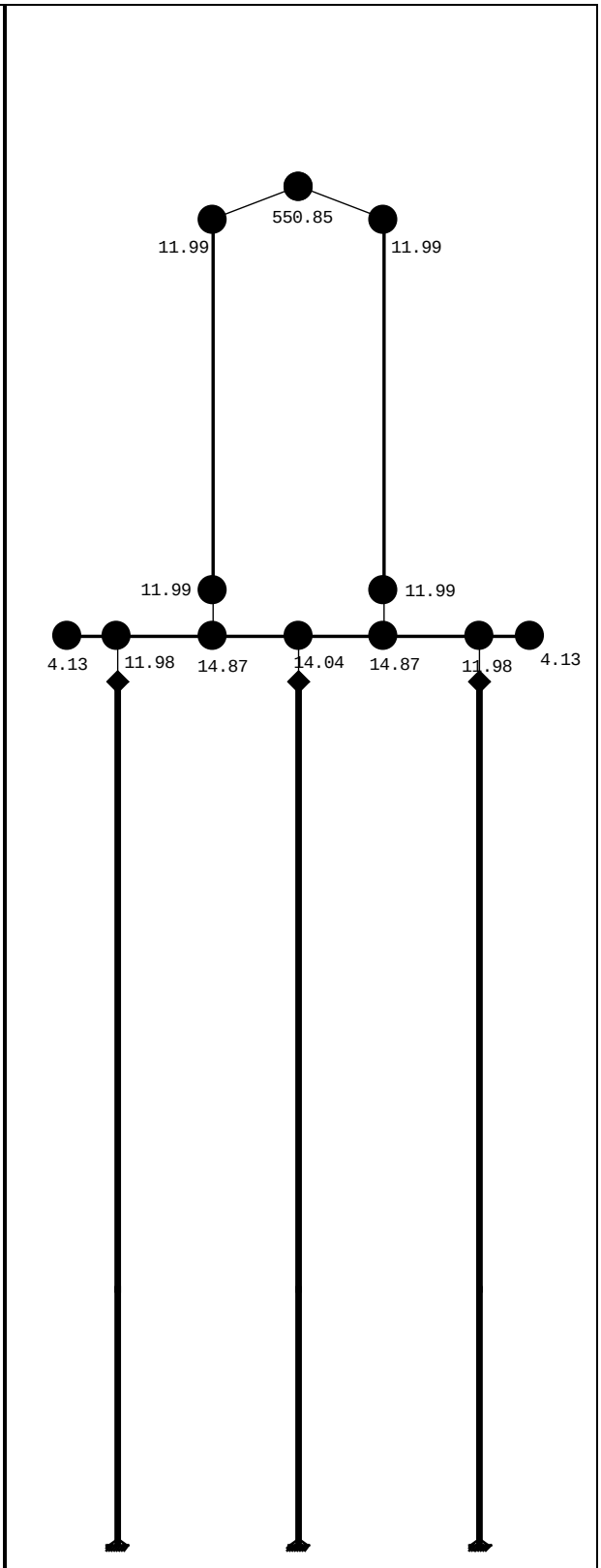
Frame: V_1 - Group: model
Mass position



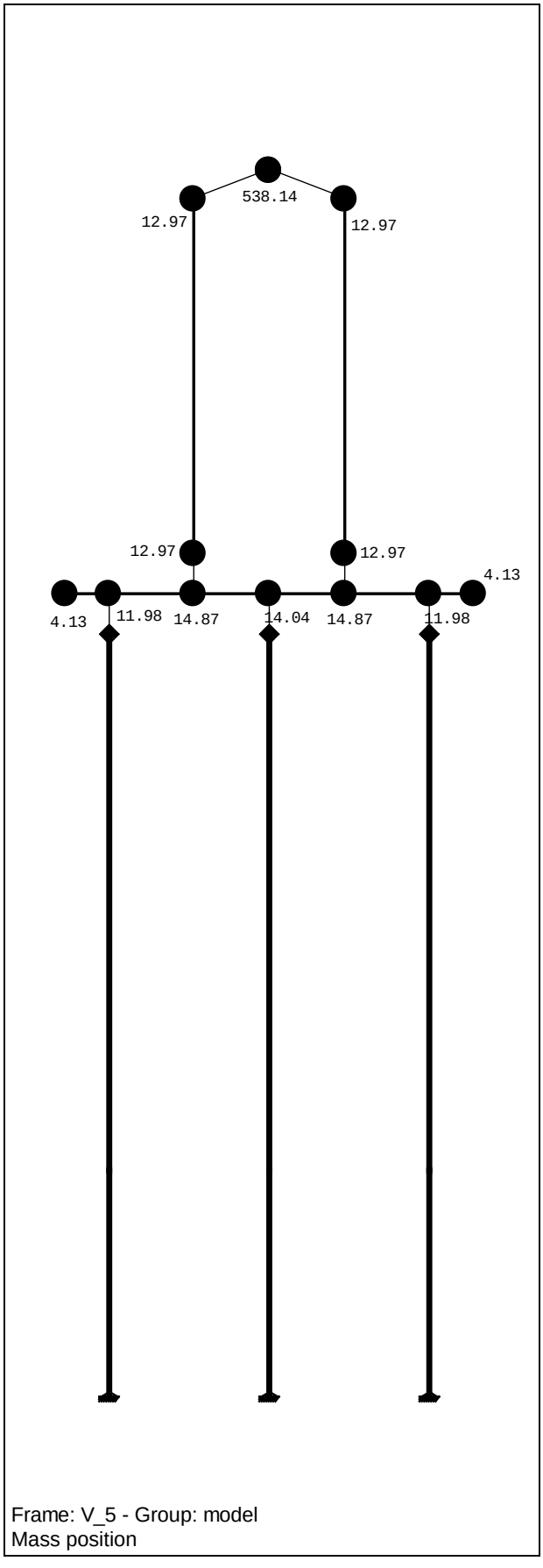
Frame: V_2 - Group: model
Mass position



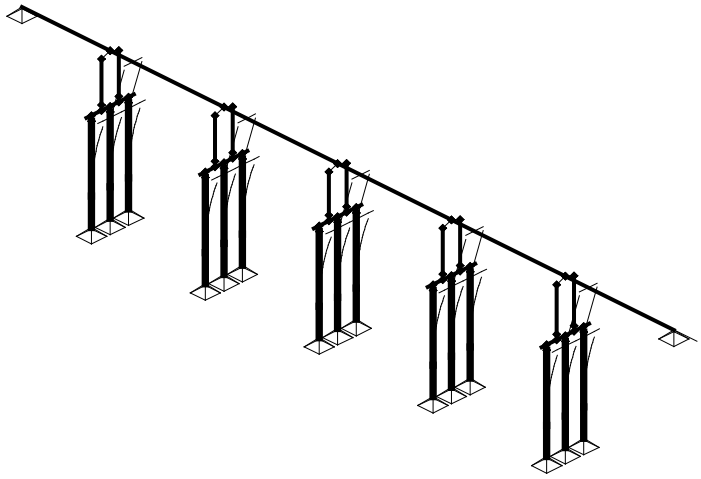
Frame: V_3 - Group: model
Mass position



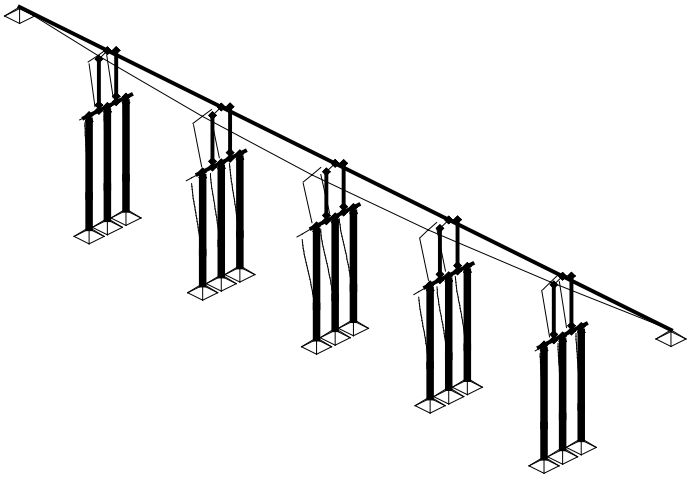
Frame: V_4 - Group: model
Mass position



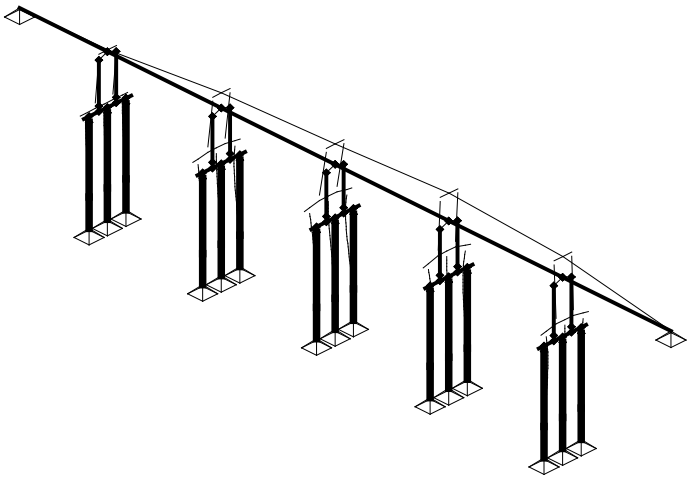
Frame: V_5 - Group: model
Mass position



Group: model
Modals 1/30 [T=1.1233sec / f=0.89Hz]



Group: model
Modals 2/30 [T=0.6195sec / f=1.61Hz]



Group: model
Modals 11/30 [T=0.1265sec / f=7.91Hz]

Seismic analysis: EC8 (EN 1998)

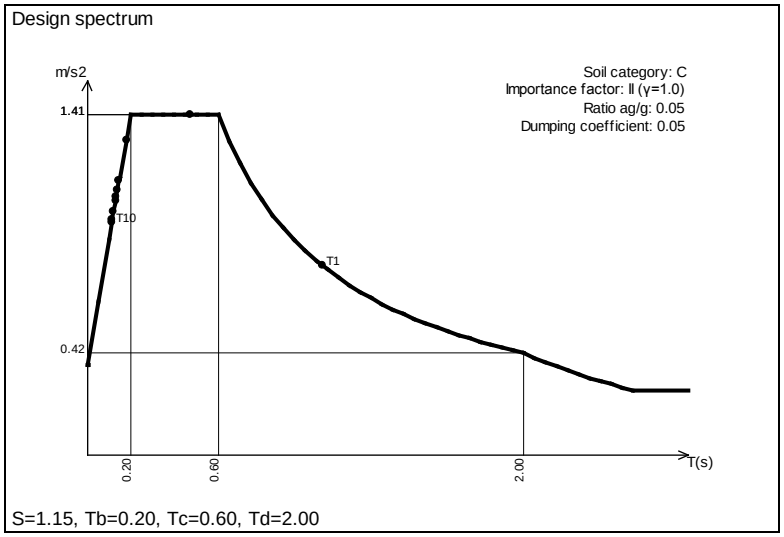
Soil category:	C
Importance factor:	II (γ=1.0)
Ratio ag/g:	0.05
Dumping coefficient:	0.05

Earthquake directional factors:

Load case	Angle α[°]	k,α	k,α+90°	kz	q
Sx	0	1.000	0.000	0.000	1.000
Sy	90	1.000	0.000	0.000	1.000
Sz	0	0.000	0.000	1.000	1.000

Type of spectrum

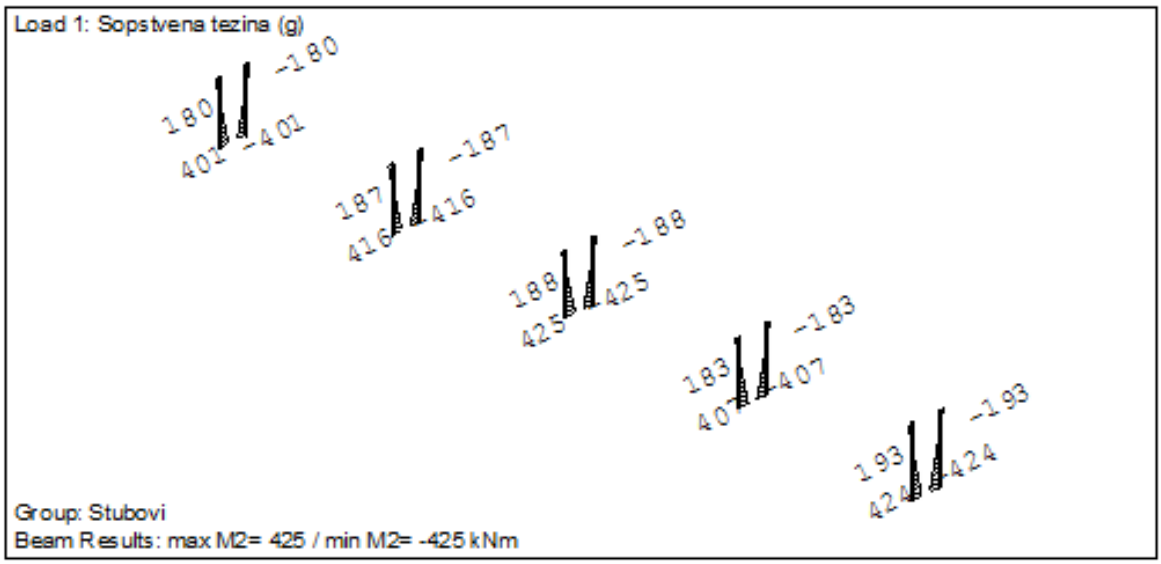
Load case	S	Tb	Tc	Td	avg/ag
Sx	1.150	0.200	0.600	2.000	1.000
Sy	1.150	0.200	0.600	2.000	1.000
Sz	1.150	0.200	0.600	2.000	1.000

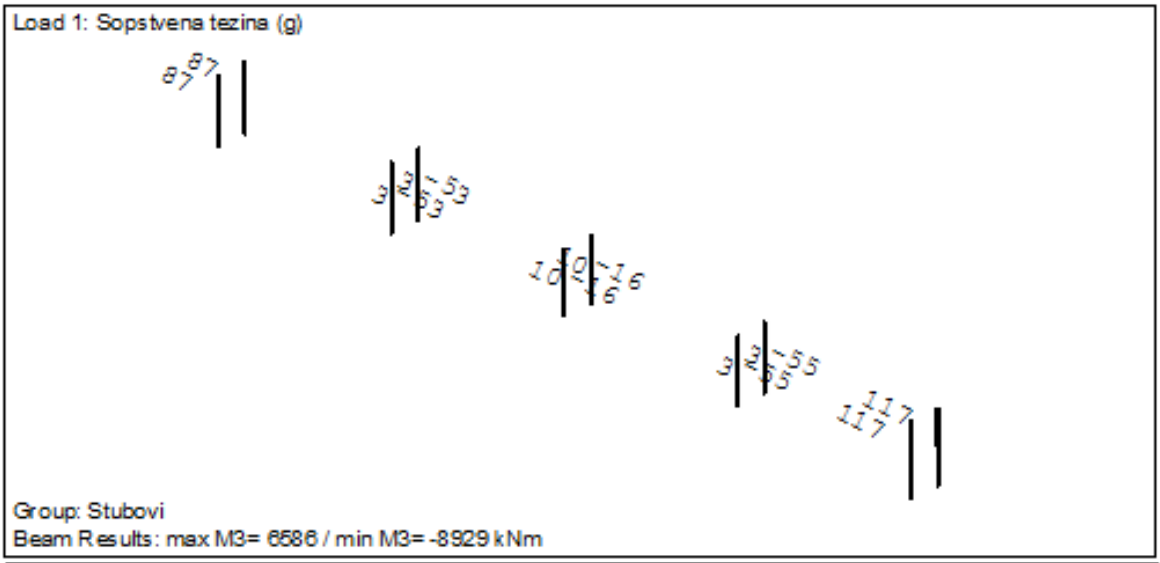


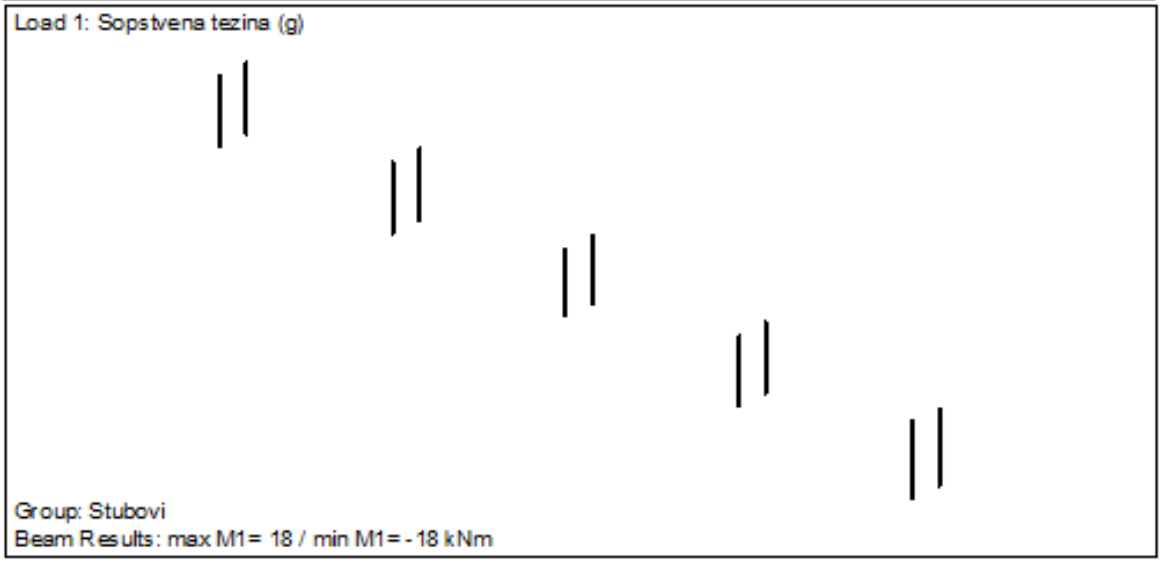
Distribution factors - mass involvement

Mode	U [α=0°]	U [α=90°]	U [α=0°]	U [Z]
1	84.28	0.00	84.28	0.00
2	0.00	69.99	0.00	0.00
3	0.00	0.02	0.00	0.00
4	0.84	0.00	0.84	0.01
5	0.00	10.00	0.00	0.00
6	0.03	0.00	0.03	0.01
7	0.21	0.00	0.21	0.00
8	2.30	0.00	2.30	0.01
9	5.76	0.00	5.76	0.00
10	0.00	2.30	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00
16	0.00	0.13	0.00	0.00
17	0.00	0.00	0.00	65.31
18	0.00	0.00	0.00	5.62
19	0.00	0.00	0.00	4.55
20	0.00	0.00	0.00	0.04
21	0.00	0.00	0.00	12.03
22	0.00	0.04	0.00	0.00
23	0.00	0.03	0.00	0.00
24	0.00	0.39	0.00	0.00
25	0.00	0.02	0.00	0.00
26	0.11	0.00	0.11	0.00
27	0.53	0.00	0.53	0.00
28	0.09	0.00	0.09	0.00
29	1.88	0.00	1.88	0.00
30	1.99	0.00	1.99	0.00
ΣU (%)	98.01	82.91	98.01	87.58

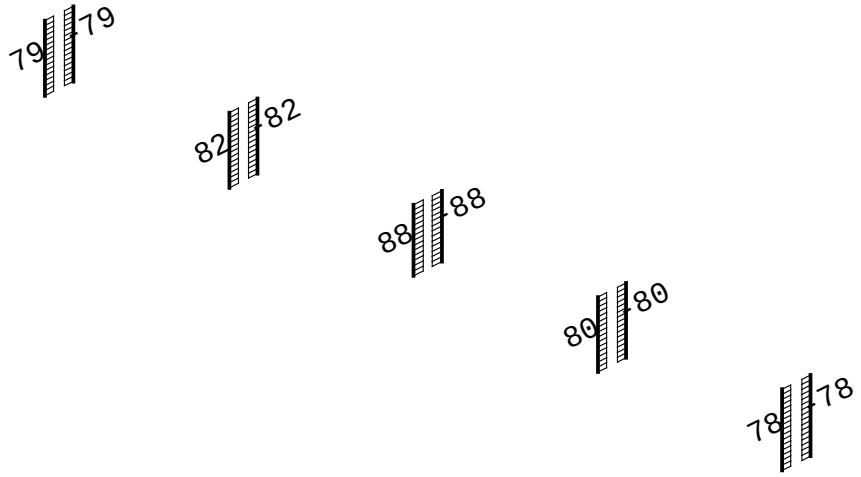
4.6.2.2 **Пресечне силе и деформације /** Internal forces and deformations





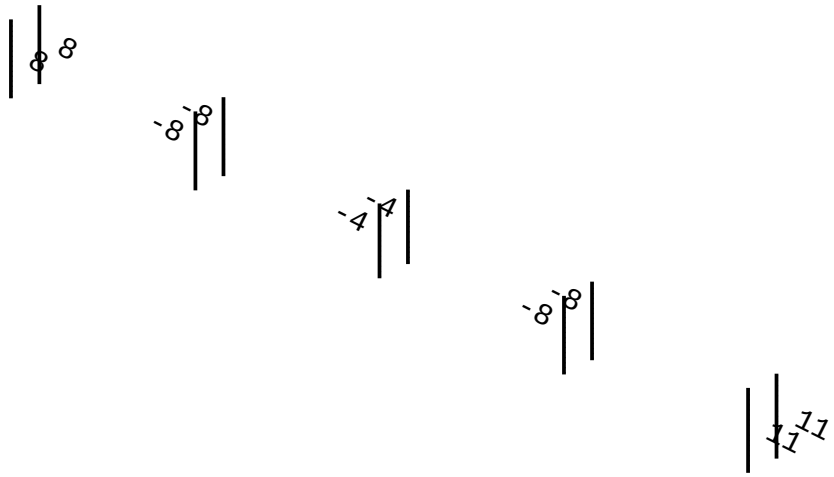


Load 1: Sopstvena tezina (g)



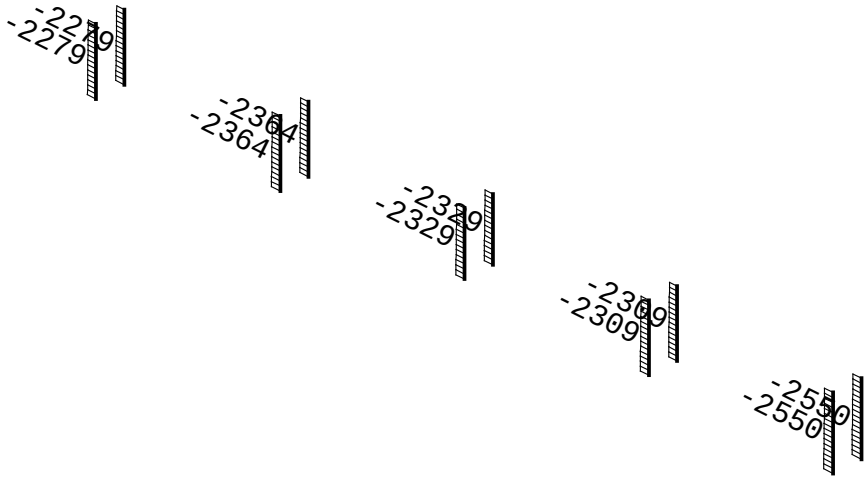
Group: Stubovi
Beam Results: max V3= 88 / min V3= -88 kN

Load 1: Sopstvena tezina (g)



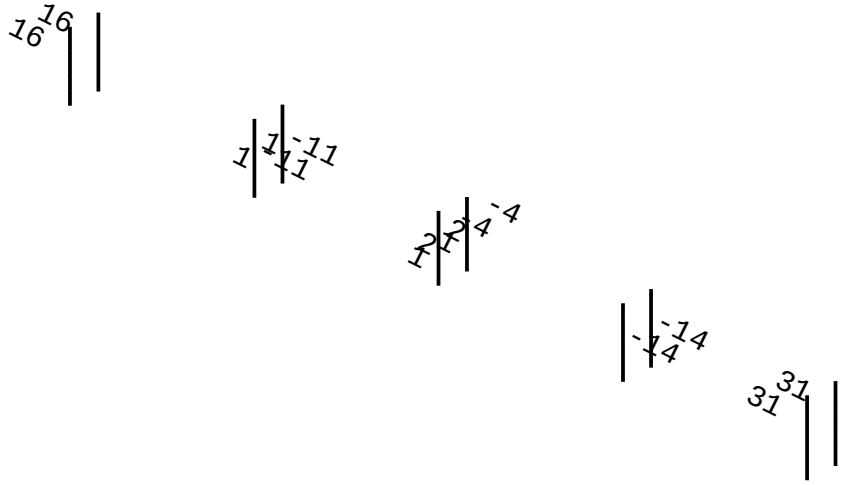
Group: Stubovi
Beam Results: max V2= 2159 / min V2= -2431 kN

Load 1: Sopstvena tezina (g)



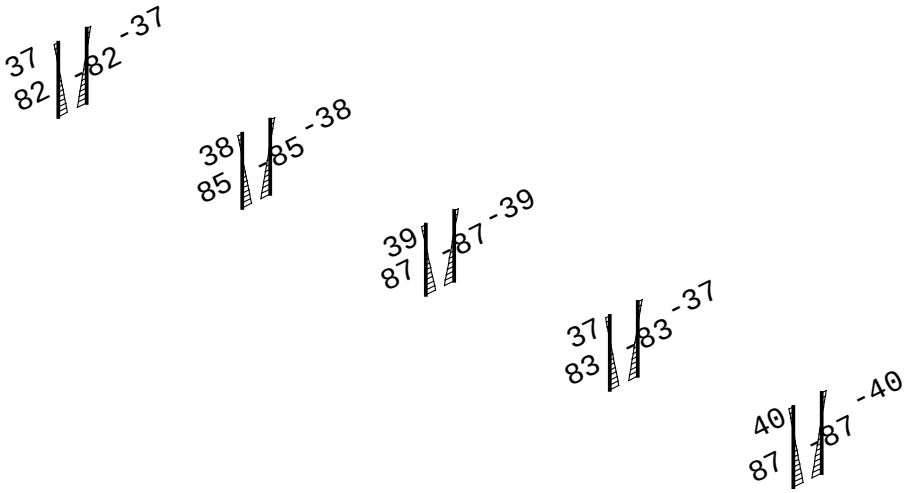
Group: Stubovi
Beam Results: max N1= 65 / min N1= -2631 kN

Load 2: Dodato stalno



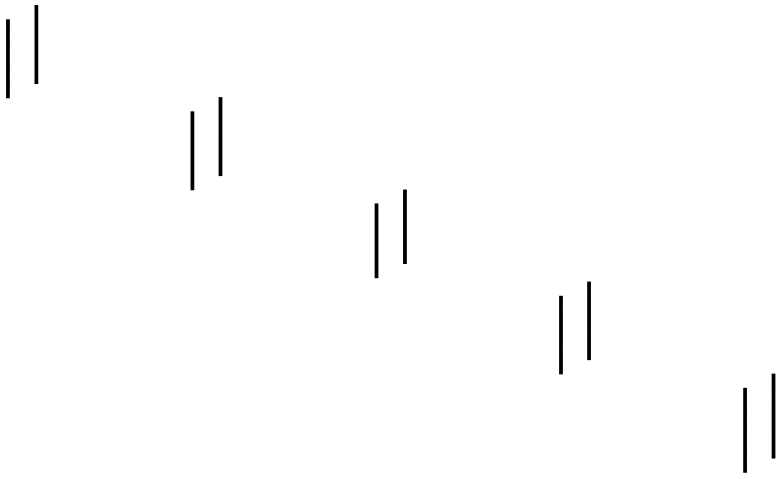
Group: Stubovi
Beam Results: max M3= 1549 / min M3= -2148 kNm

Load 2: Dodato stalno



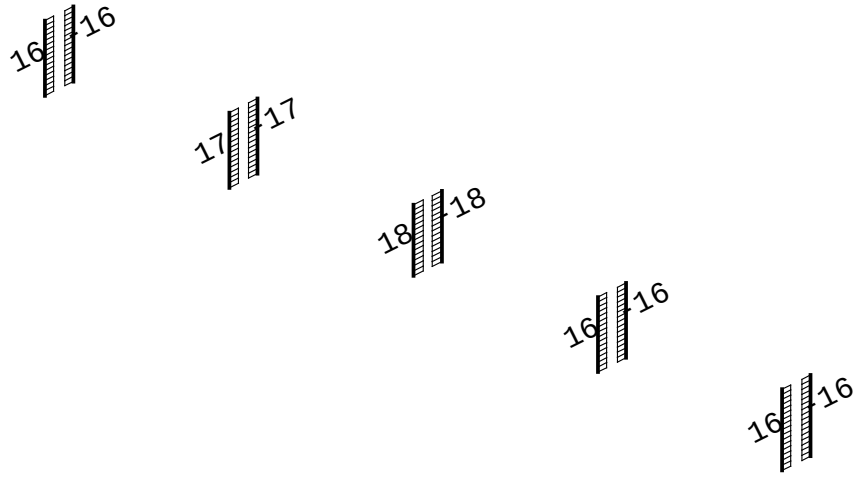
Group: Stubovi
Beam Results: max M2= 87 / min M2= -87 kNm

Load 2: Dodato stalno



Group: Stubovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 2: Dodato stalno

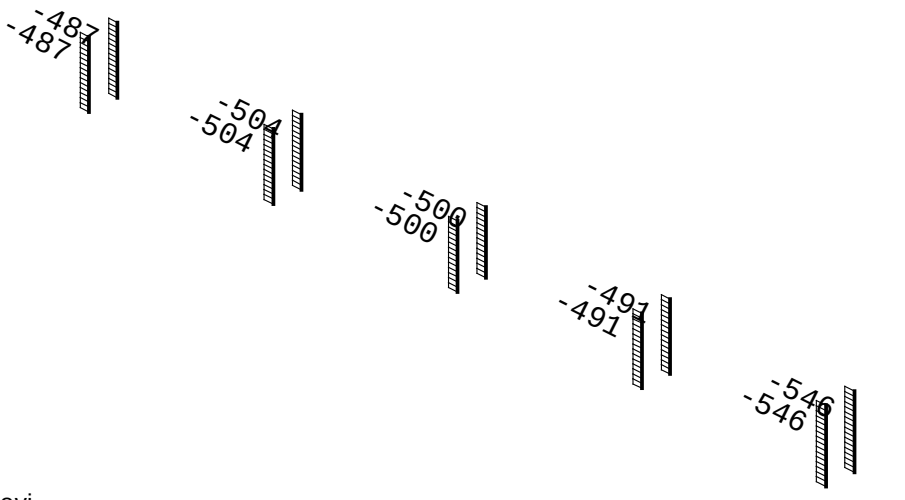


Group: Stubovi
Beam Results: max V3= 18 / min V3= -18 kN

Load 2: Dodato stalno

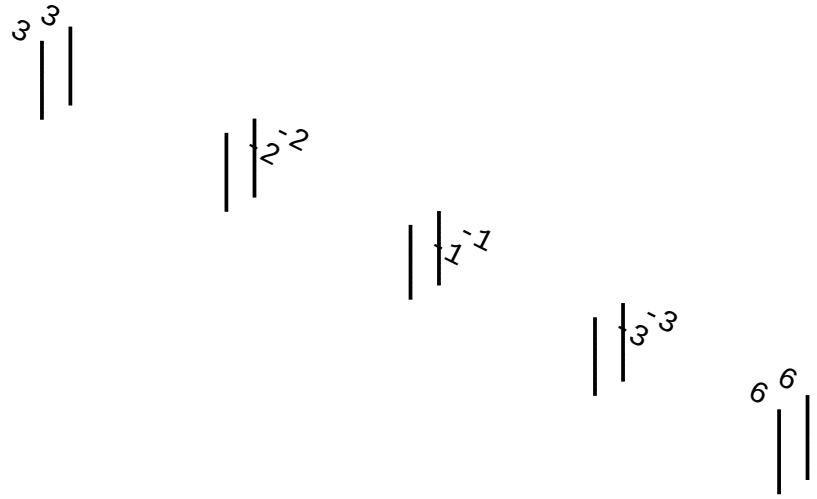
Group: Stubovi
Beam Results: max V2= 513 / min V2= -578 kN

Load 2: Dodato stalno



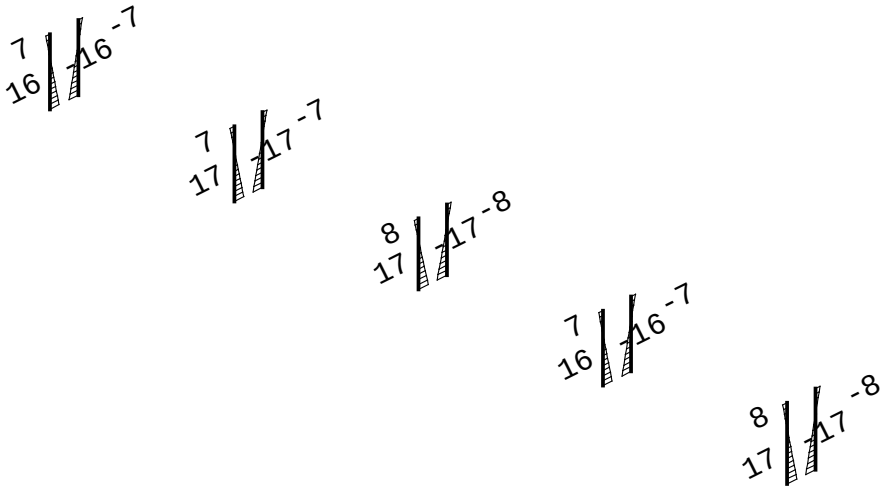
Group: Stubovi
Beam Results: max N1= 13 / min N1= -546 kN

Load 3: UDL (20%)



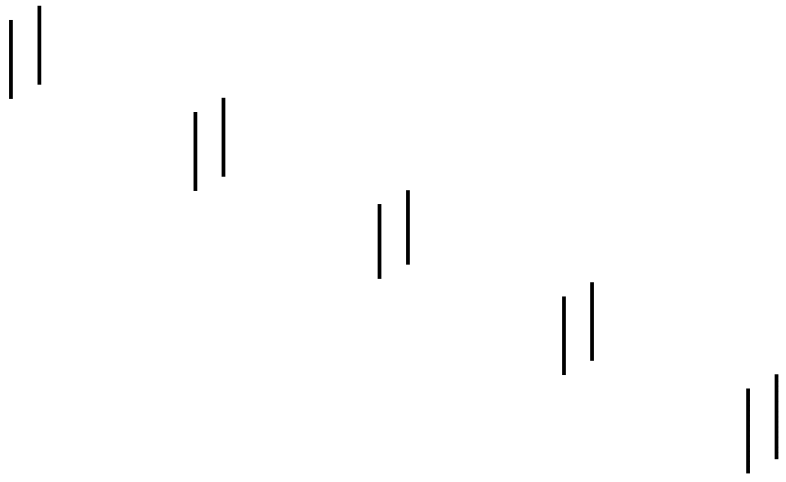
Group: Stubovi
Beam Results: max M3= 302 / min M3= -418 kNm

Load 3: UDL (20%)



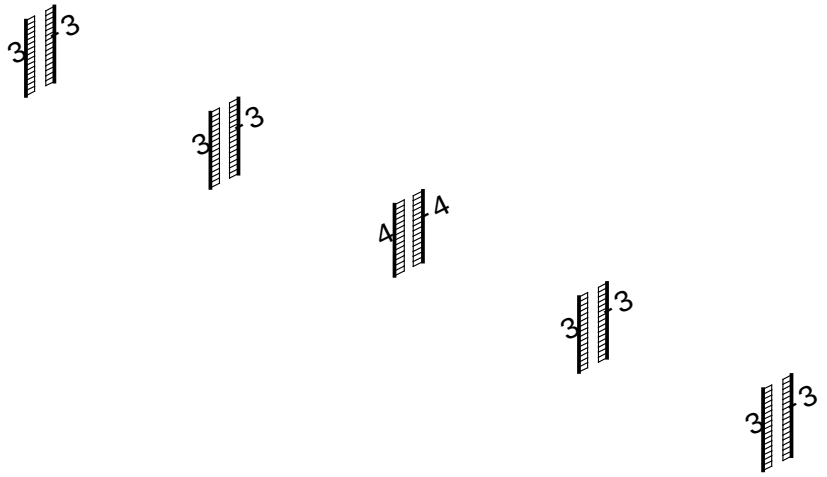
Group: Stubovi
Beam Results: max M2= 17 / min M2= -17 kNm

Load 3: UDL (20%)



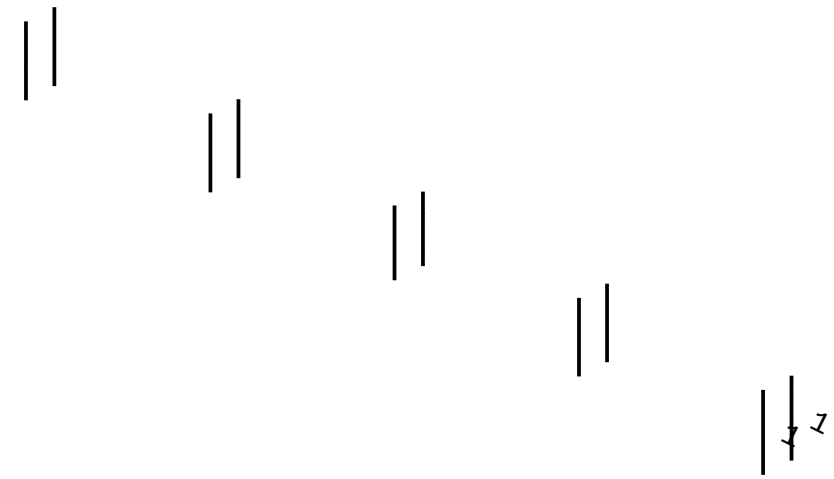
Group: Stubovi
Beam Results: max M1= 1 / min M1= -1 kNm

Load 3: UDL (20%)



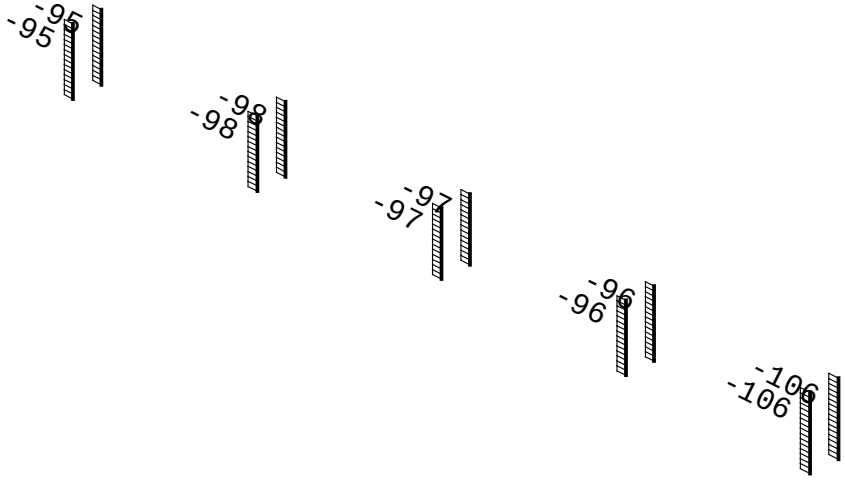
Group: Stubovi
Beam Results: max V3= 4 / min V3= -4 kN

Load 3: UDL (20%)



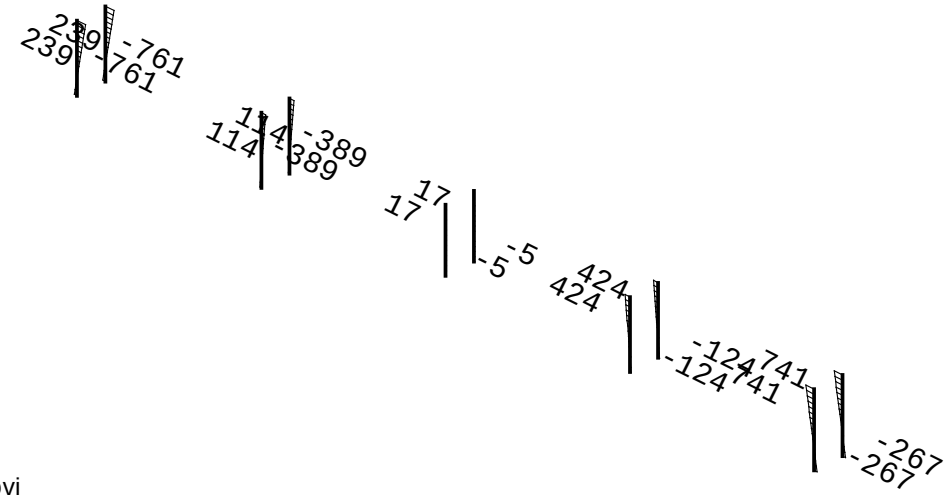
Group: Stubovi
Beam Results: max V2= 100 / min V2= -113 kN

Load 3: UDL (20%)



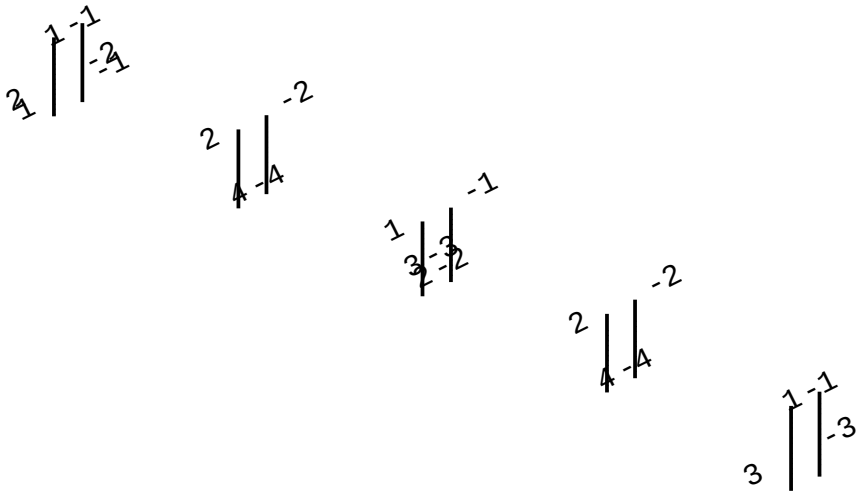
Group: Stubovi
Beam Results: max N1= 3 / min N1= -106 kN

Load 4: Skupljanje



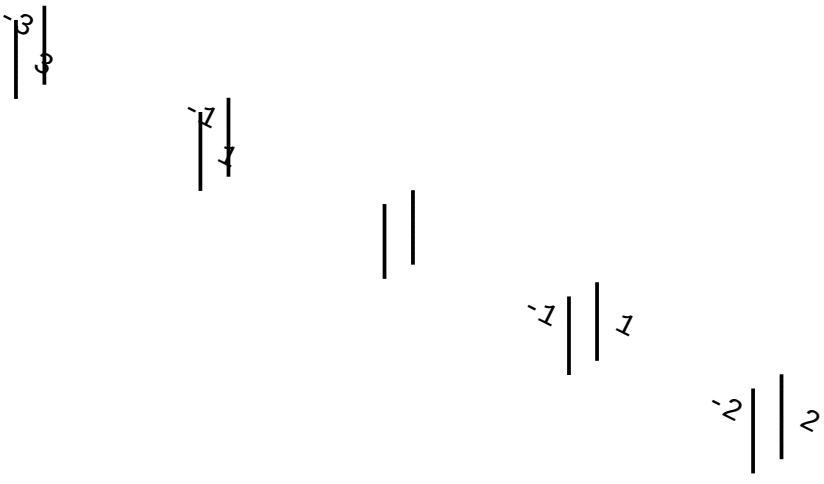
Group: Stubovi
Beam Results: max M3= 870 / min M3= -761 kNm

Load 4: Skupljanje



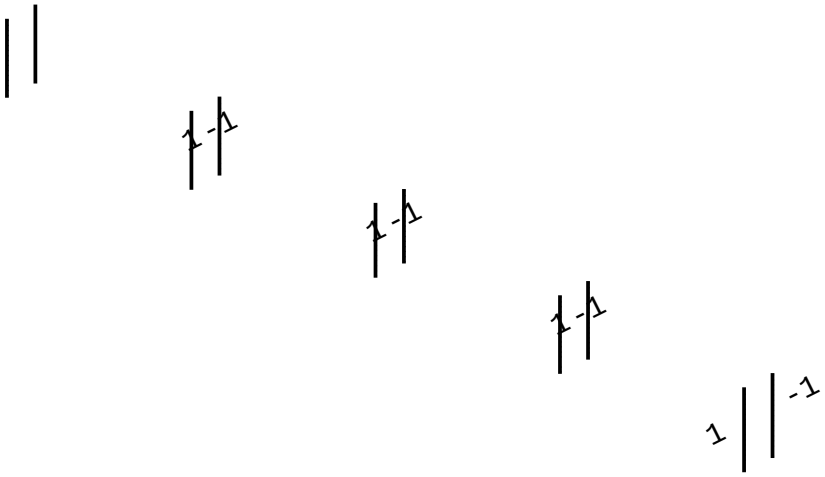
Group: Stubovi
Beam Results: max M2= 172 / min M2= -161 kNm

Load 4: Skupljanje



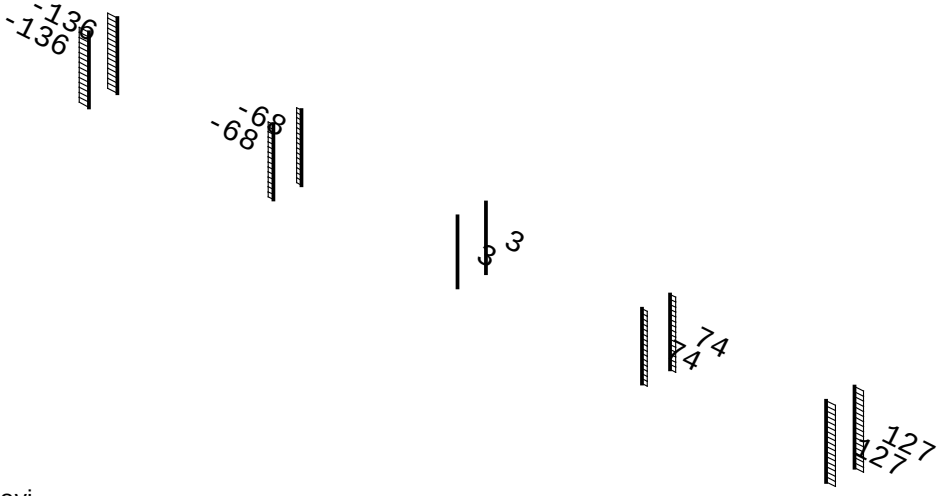
Group: Stubovi
Beam Results: max M1= 176 / min M1= -176 kNm

Load 4: Skupljanje



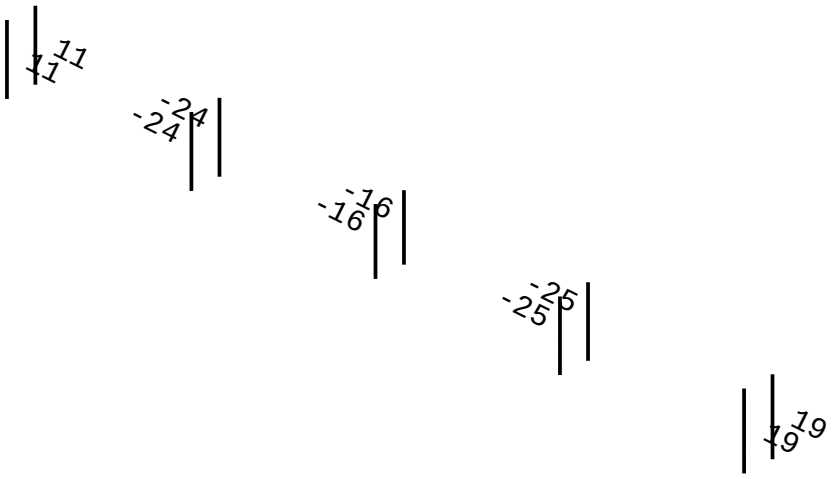
Group: Stubovi
Beam Results: max V3= 91 / min V3= -91 kN

Load 4: Skupljanje



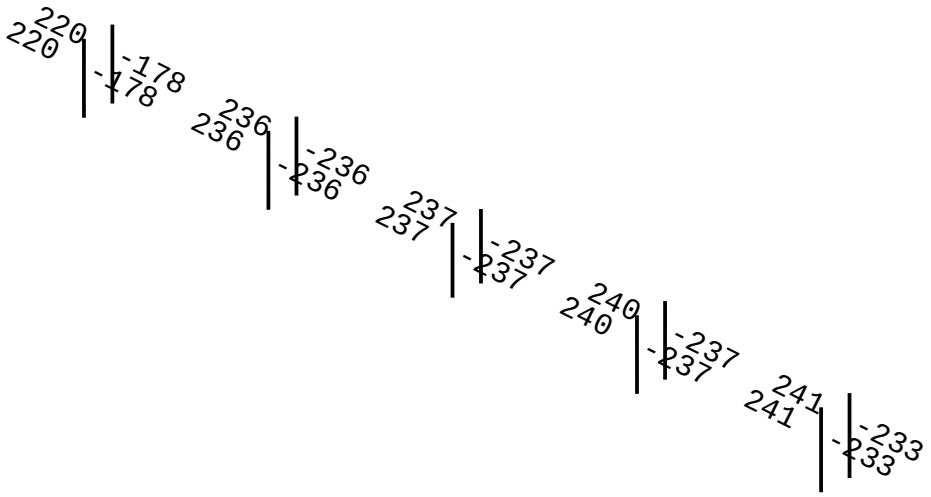
Group: Stubovi
Beam Results: max V2= 127 / min V2= -136 kN

Load 4: Skupljanje



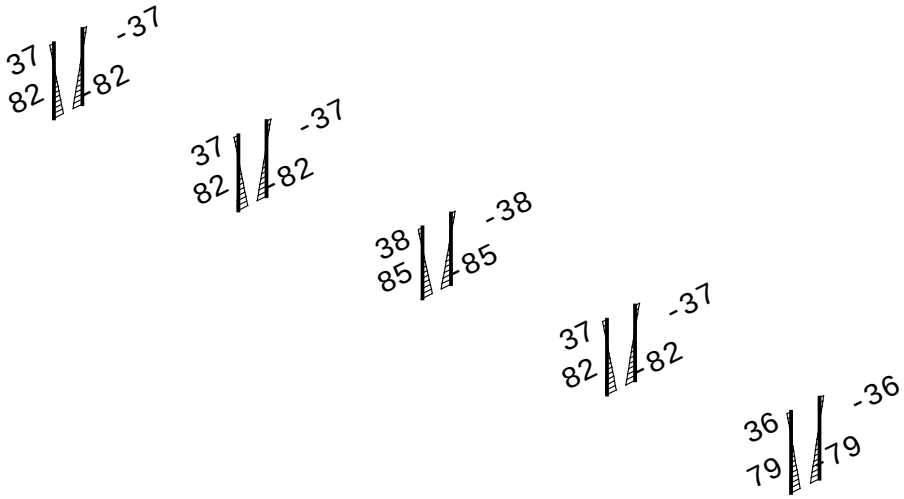
Group: Stubovi
Beam Results: max N1= 409 / min N1= -25 kN

Load 5: TS



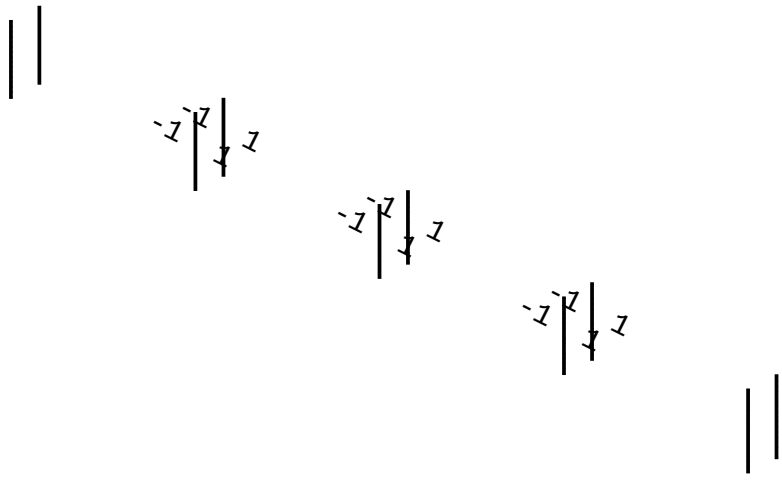
Group: Stubovi
Beam Results: max M3= 3997 / min M3= -2252 kNm

Load 5: TS



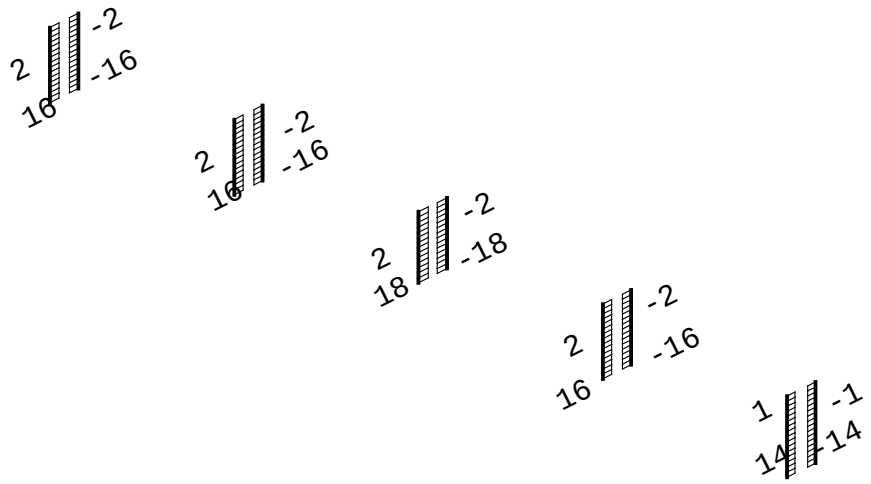
Group: Stubovi
Beam Results: max M2= 85 / min M2= -85 kNm

Load 5: TS



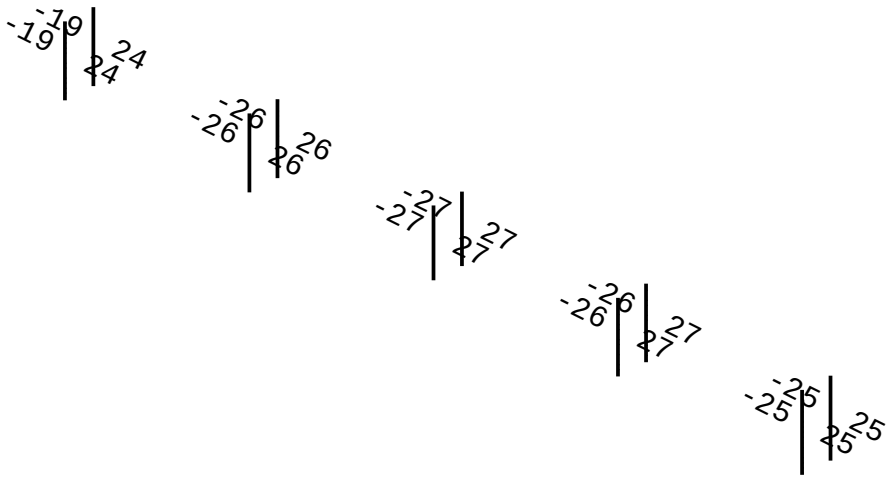
Group: Stubovi
Beam Results: max M1= 34 / min M1= -34 kNm

Load 5: TS



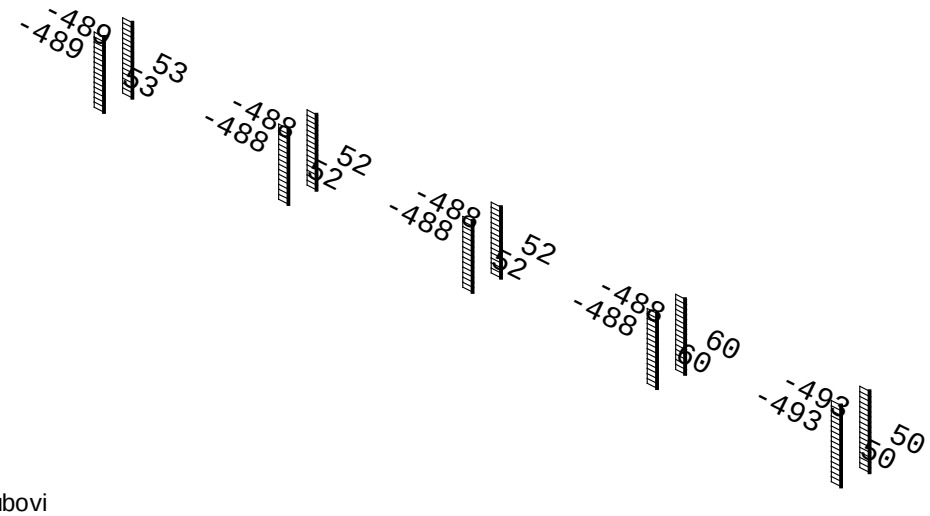
Group: Stubovi
Beam Results: max V3= 18 / min V3= -18 kN

Load 5: TS



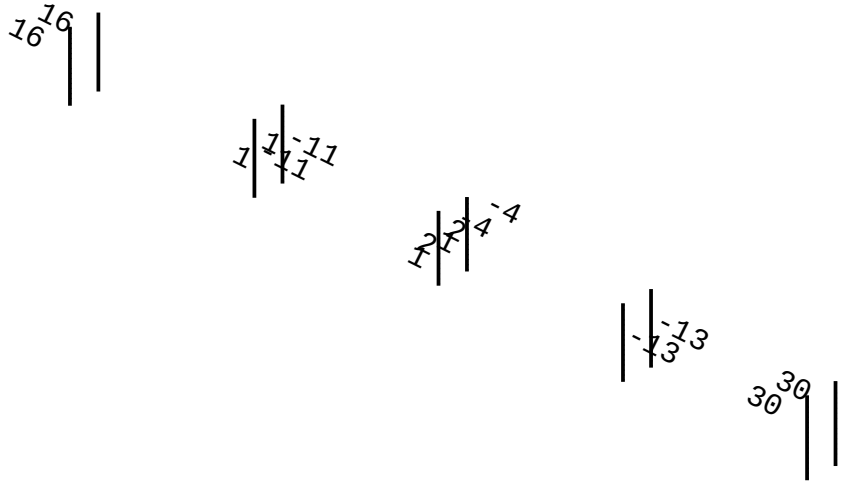
Group: Stubovi
Beam Results: max V2= 969 / min V2= -969 kN

Load 5: TS



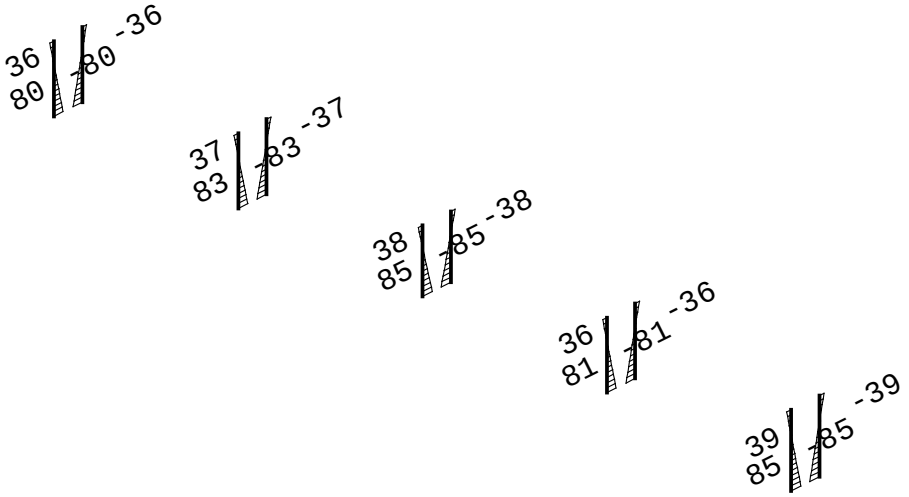
Group: Stubovi
Beam Results: max N1= 60 / min N1= -493 kN

Load 6: UDL



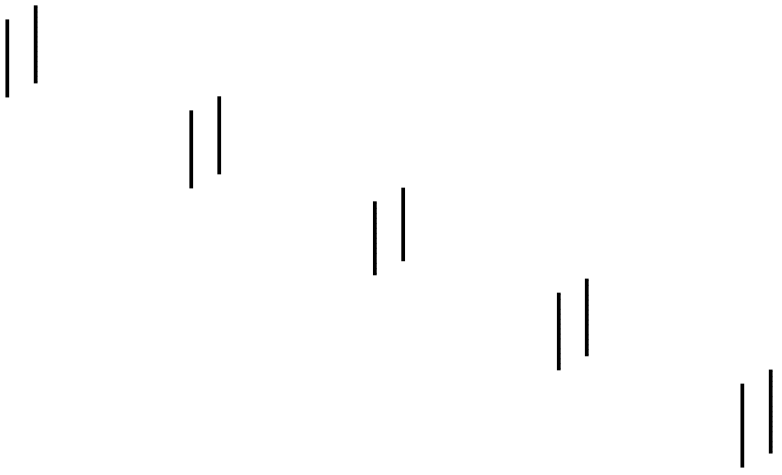
Group: Stubovi
Beam Results: max M3= 1510 / min M3= -2092 kNm

Load 6: UDL



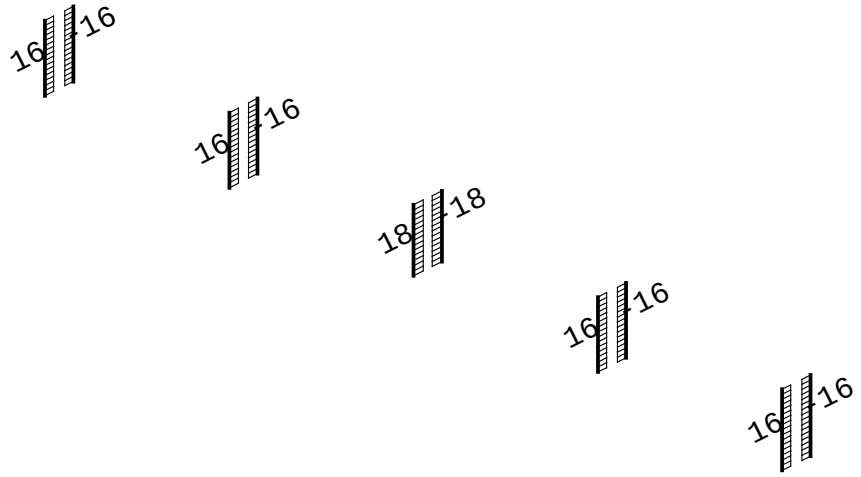
Group: Stubovi
Beam Results: max M2= 85 / min M2= -85 kNm

Load 6: UDL



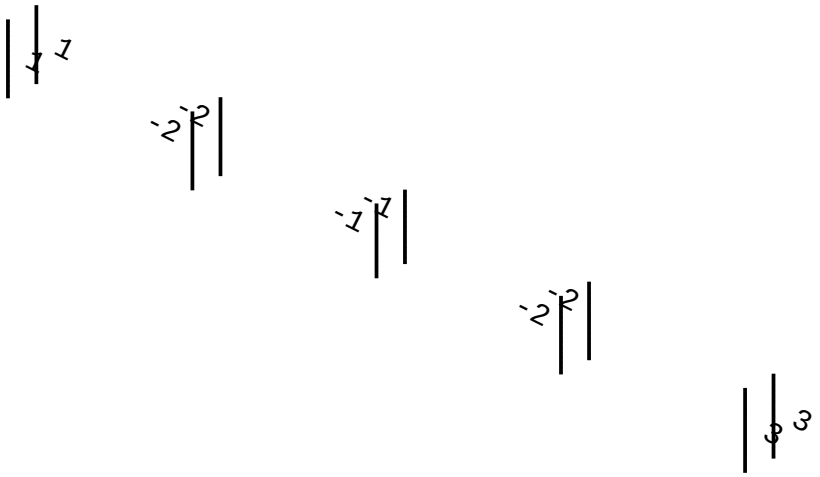
Group: Stubovi
Beam Results: max M1= 4 / min M1= -4 kNm

Load 6: UDL



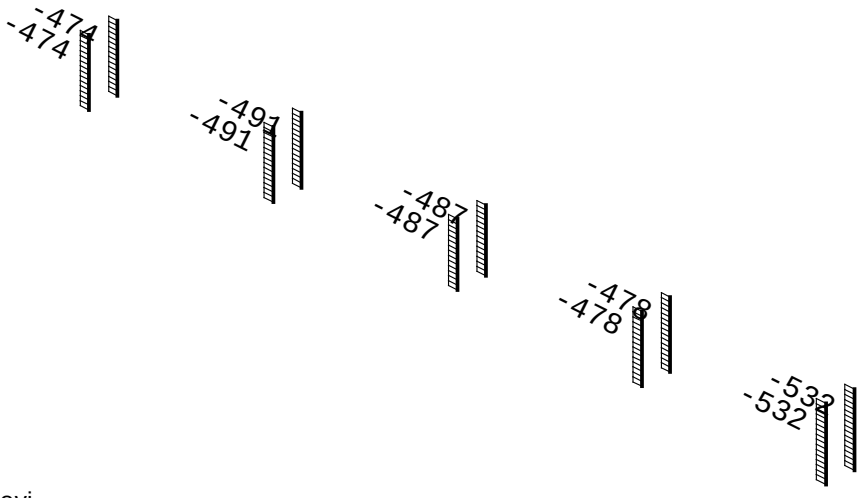
Group: Stubovi
Beam Results: max V3= 18 / min V3= -18 kN

Load 6: UDL



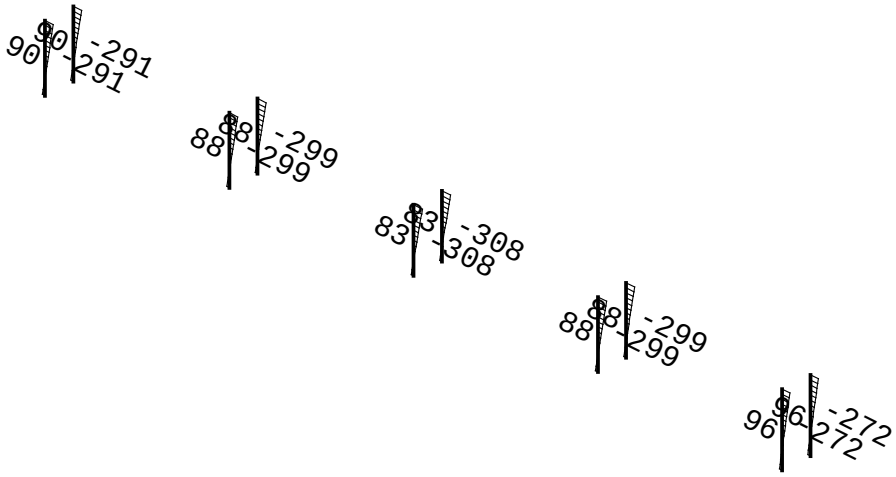
Group: Stubovi
Beam Results: max V2= 500 / min V2= -563 kN

Load 6: UDL



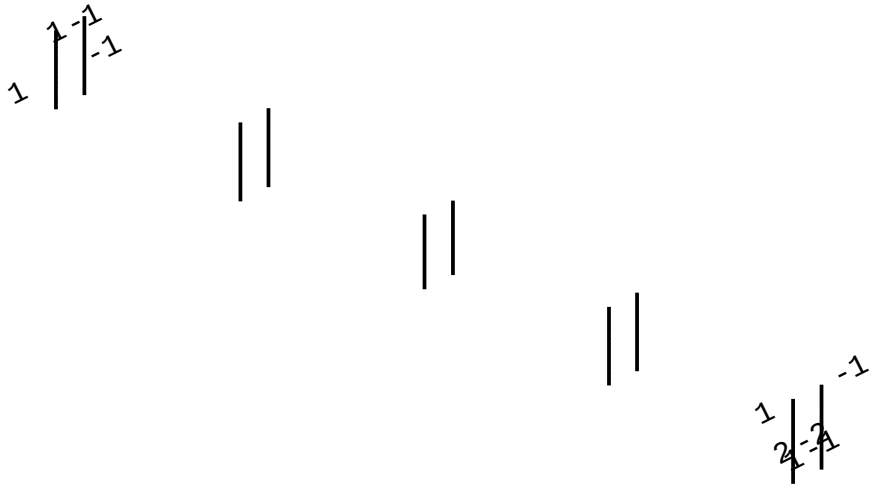
Group: Stubovi
Beam Results: max N1= 13 / min N1= -532 kN

Load 7: Kocenje



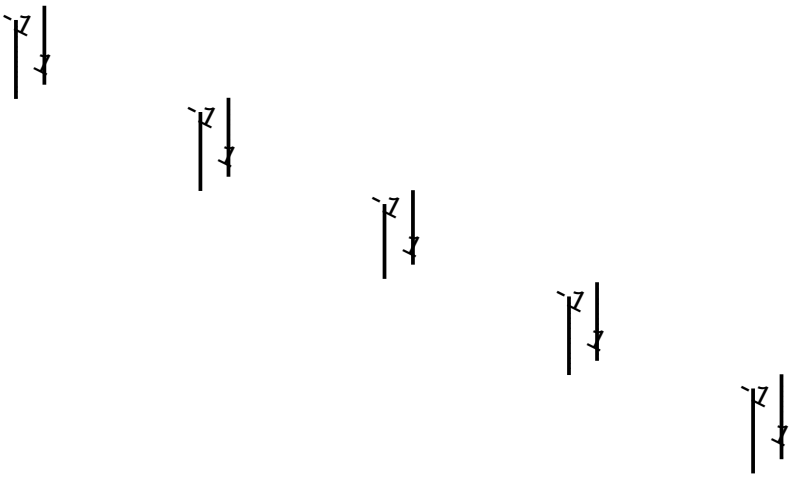
Group: Stubovi
Beam Results: max M3= 337 / min M3= -341 kNm

Load 7: Kocenje



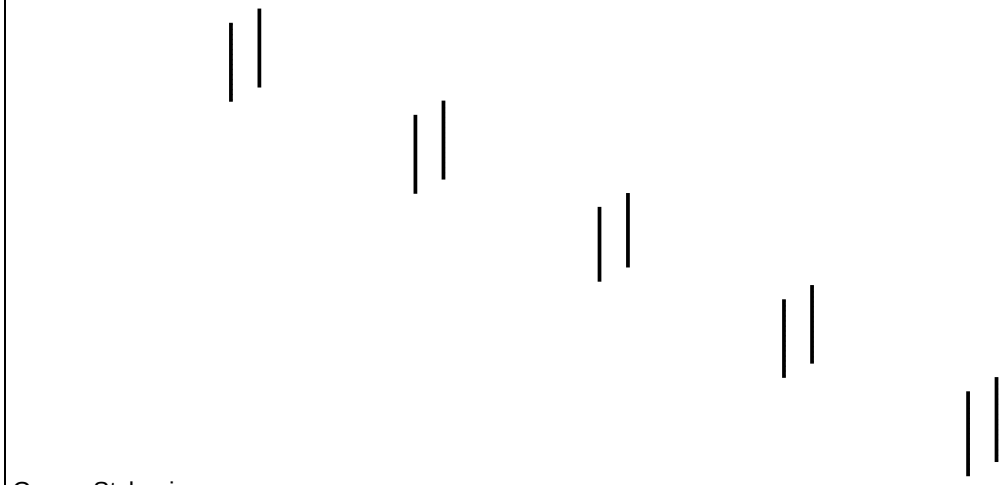
Group: Stubovi
Beam Results: max M2= 71 / min M2= -2 kNm

Load 7: Kocenje



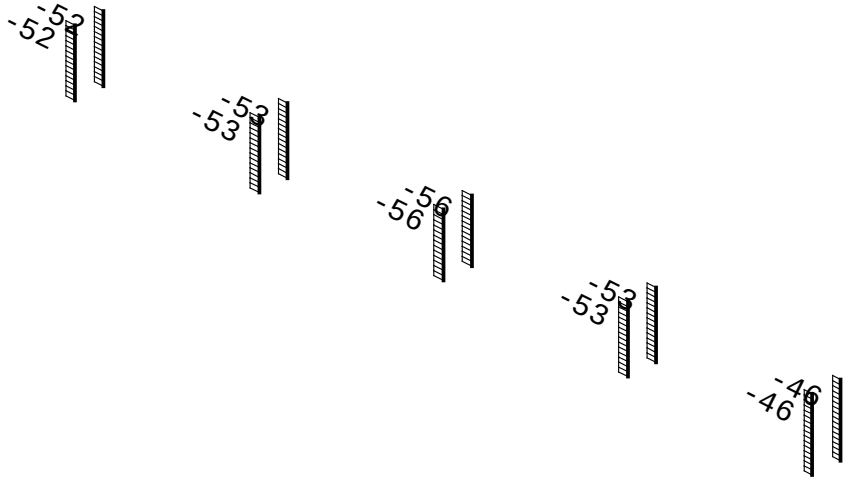
Group: Stubovi
Beam Results: max M1= 64 / min M1= -64 kNm

Load 7: Kocenje



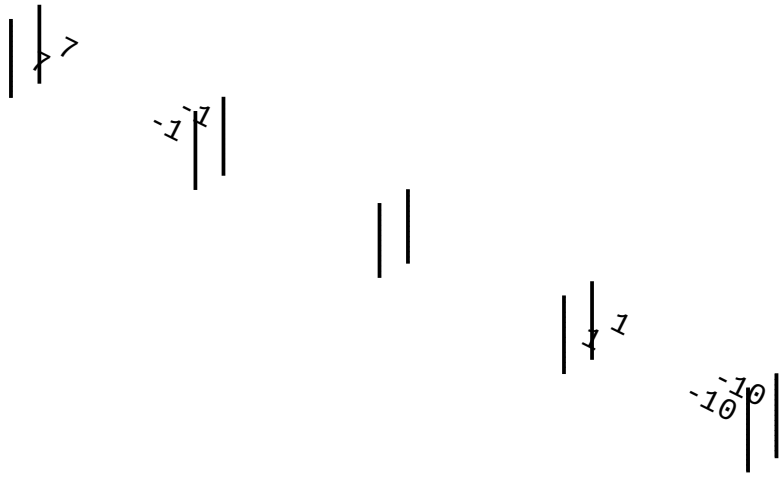
Group: Stubovi
Beam Results: max V3= 37 / min V3= -37 kN

Load 7: Kocenje



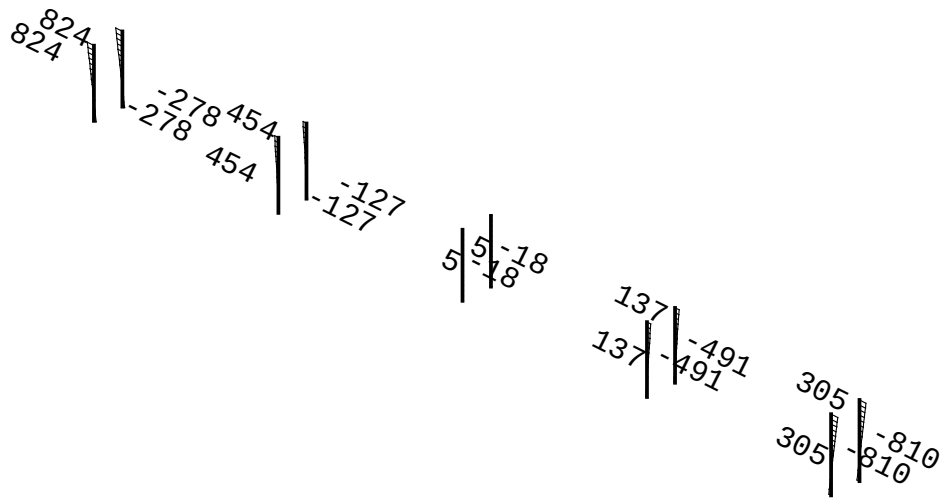
Group: Stubovi
Beam Results: max V2= 29 / min V2= -56 kN

Load 7: Kocenje



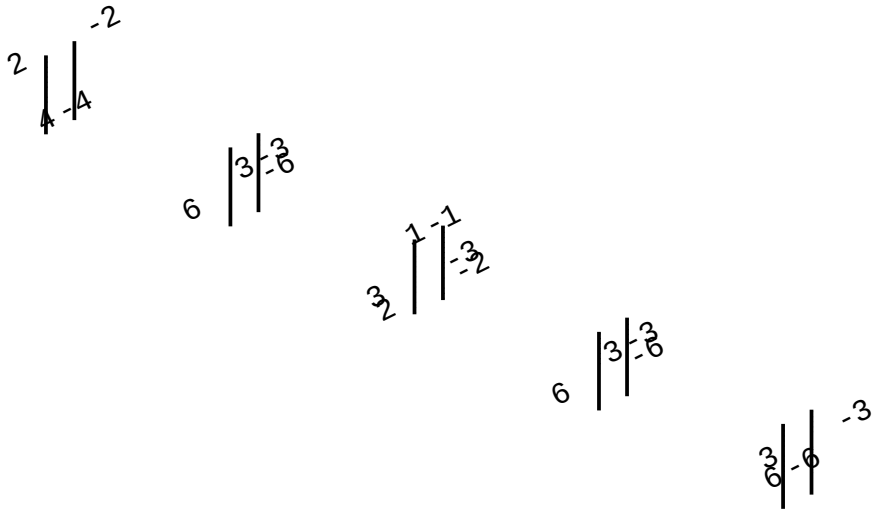
Group: Stubovi
Beam Results: max N1= 86 / min N1= -70 kN

Load 8: to+34



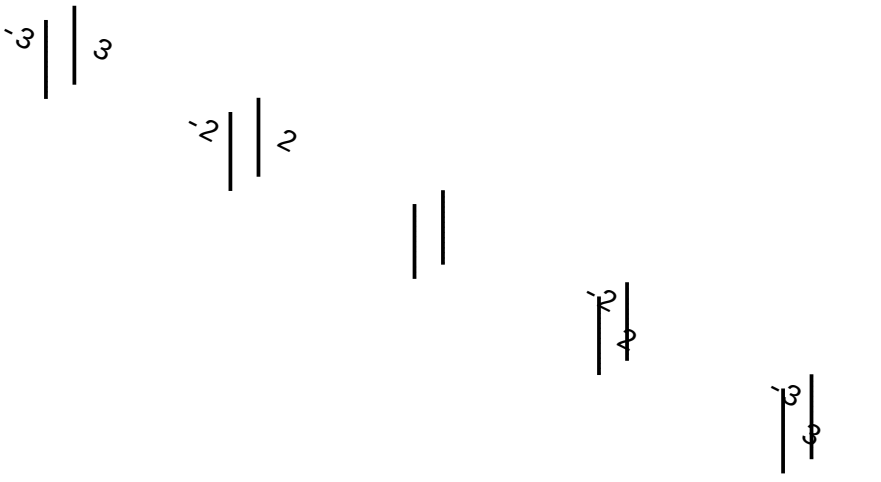
Group: Stubovi
Beam Results: max M3= 824 / min M3= -1212 kNm

Load 8: to+34



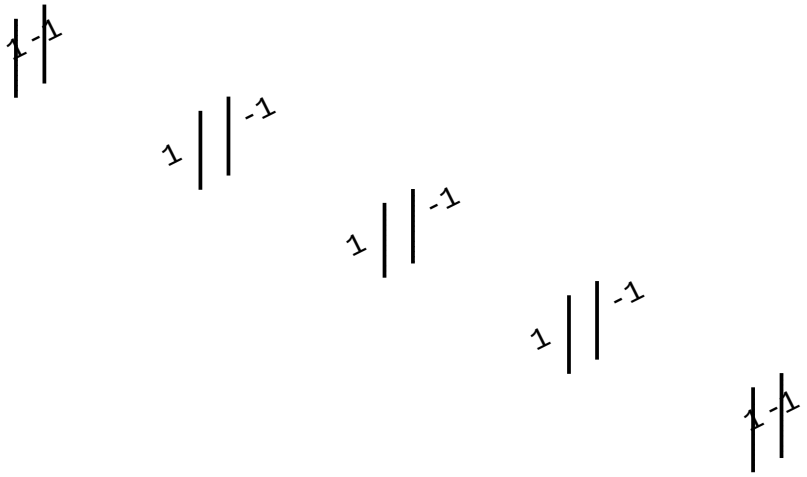
Group: Stubovi
Beam Results: max M2= 178 / min M2= -190 kNm

Load 8: to+34



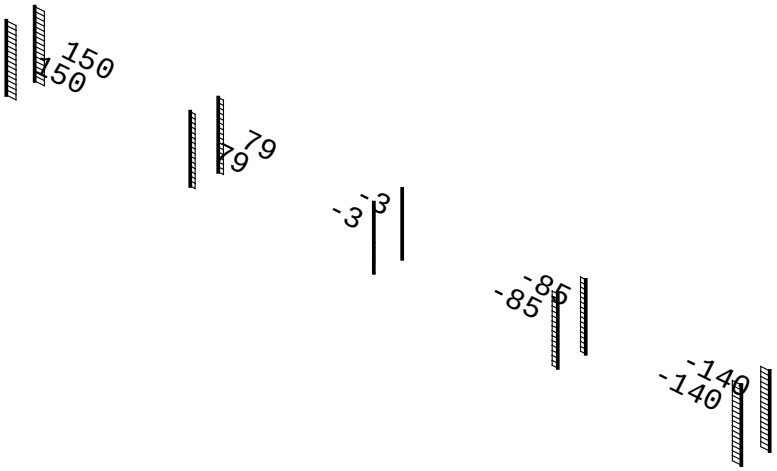
Group: Stubovi
Beam Results: max M1= 202 / min M1= -202 kNm

Load 8: to+34



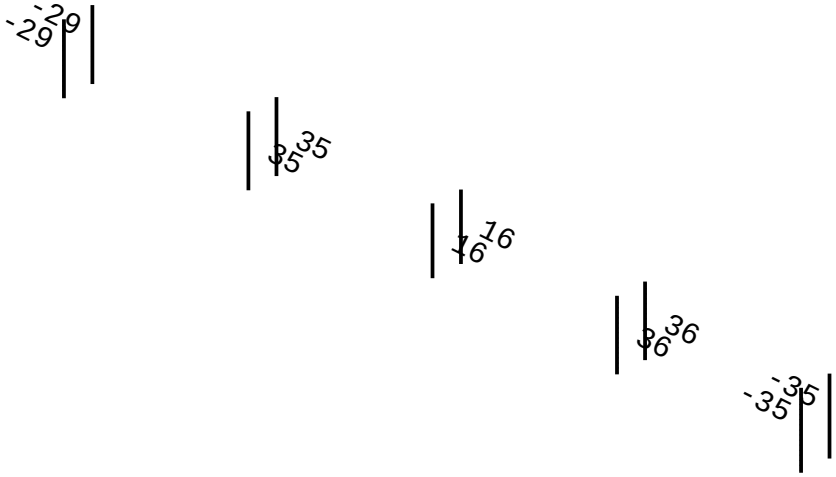
Group: Stubovi
Beam Results: max V3= 100 / min V3= -100 kN

Load 8: to+34



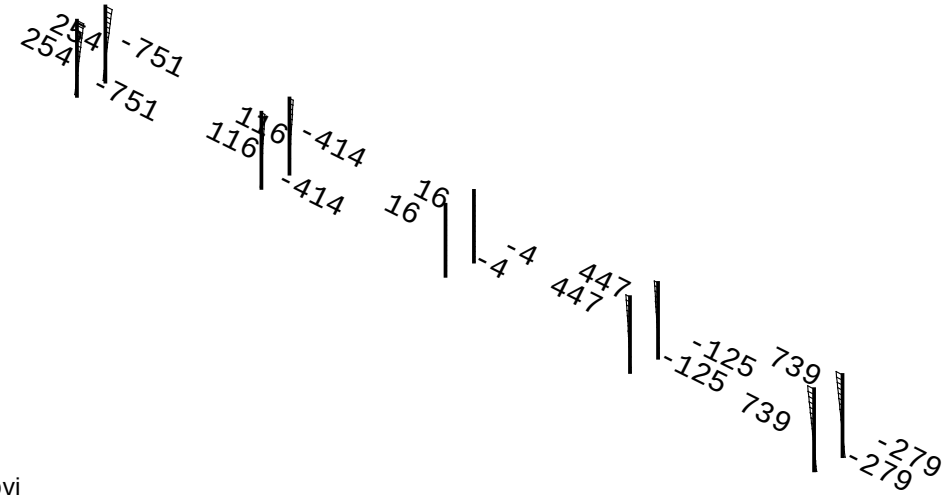
Group: Stubovi
Beam Results: max V2= 150 / min V2= -140 kN

Load 8: to+34



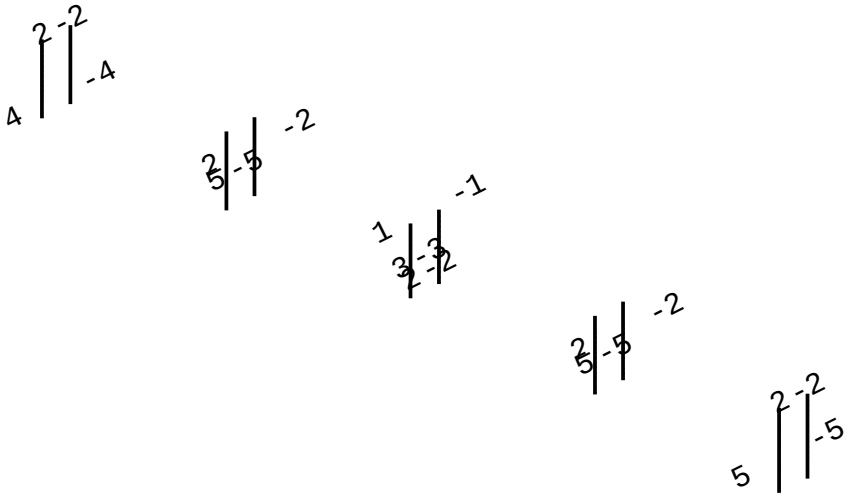
Group: Stubovi
Beam Results: max N1= 36 / min N1= -458 kN

Load 9: to-31



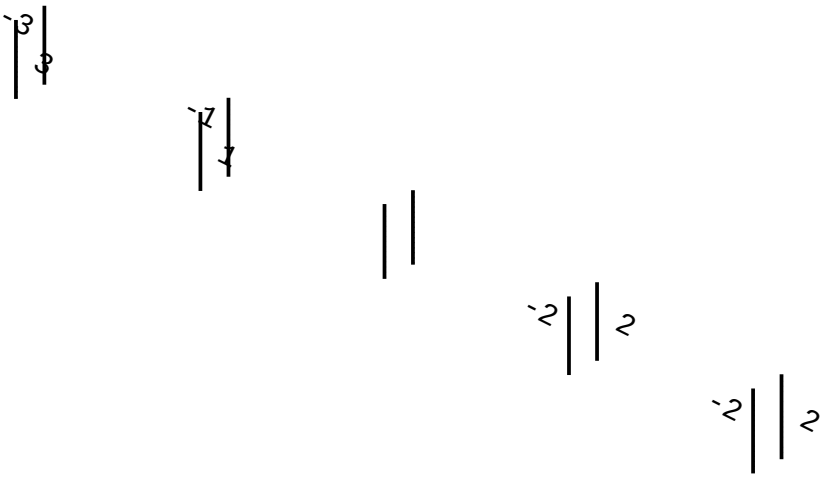
Group: Stubovi
Beam Results: max M3= 1105 / min M3= -751 kNm

Load 9: to-31



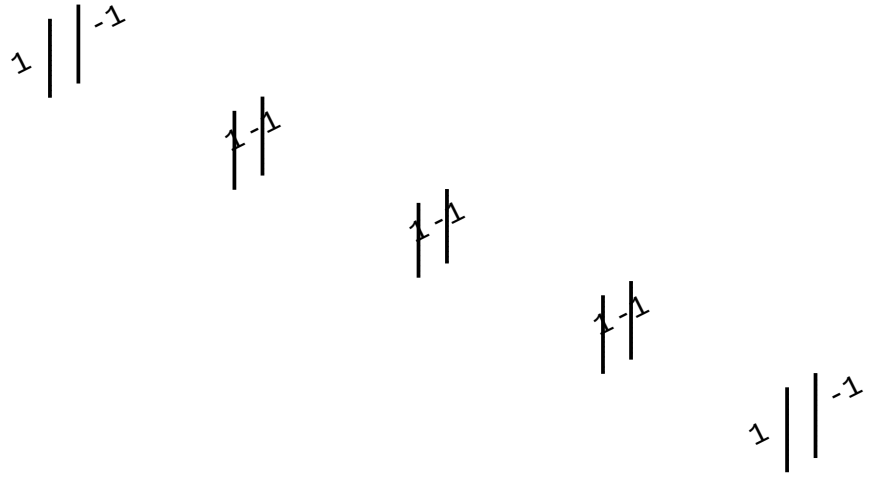
Group: Stubovi
Beam Results: max M2= 173 / min M2= -162 kNm

Load 9: to-31



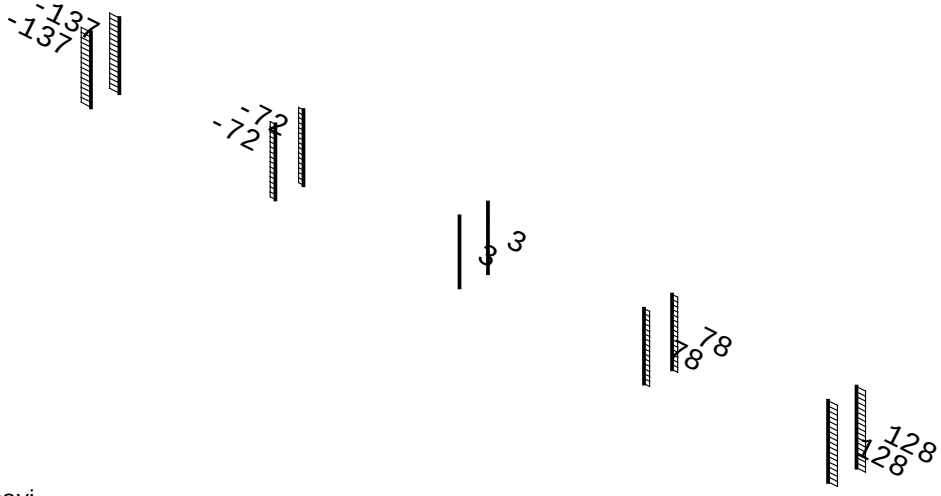
Group: Stubovi
Beam Results: max M1= 184 / min M1= -184 kNm

Load 9: to-31



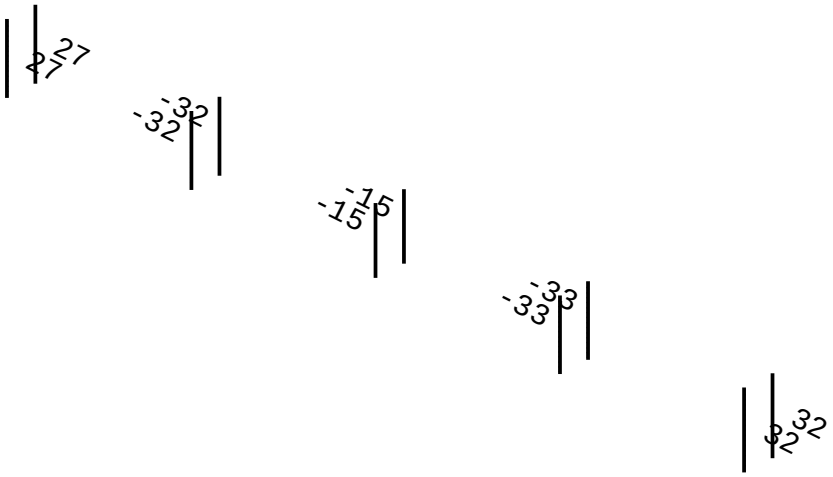
Group: Stubovi
Beam Results: max V3= 91 / min V3= -91 kN

Load 9: to-31



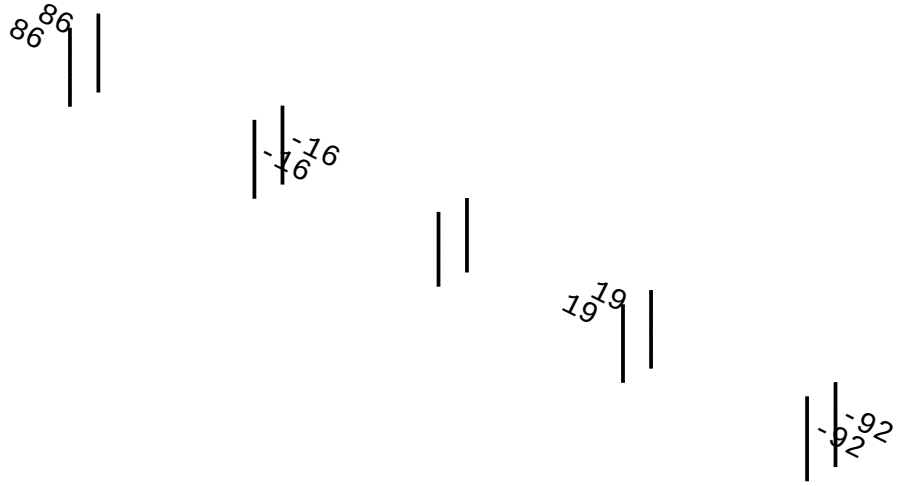
Group: Stubovi
Beam Results: max V2= 128 / min V2= -137 kN

Load 9: to-31



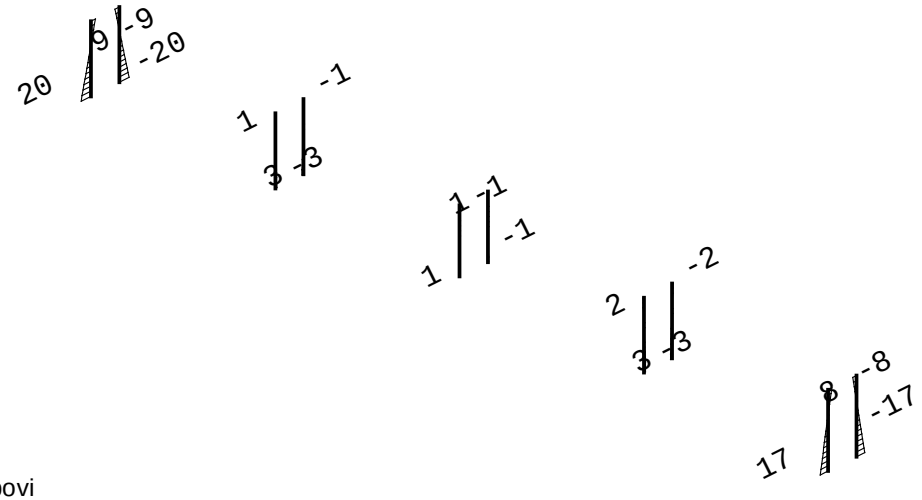
Group: Stubovi
Beam Results: max N1= 418 / min N1= -33 kN

Load 10: dt+12.3



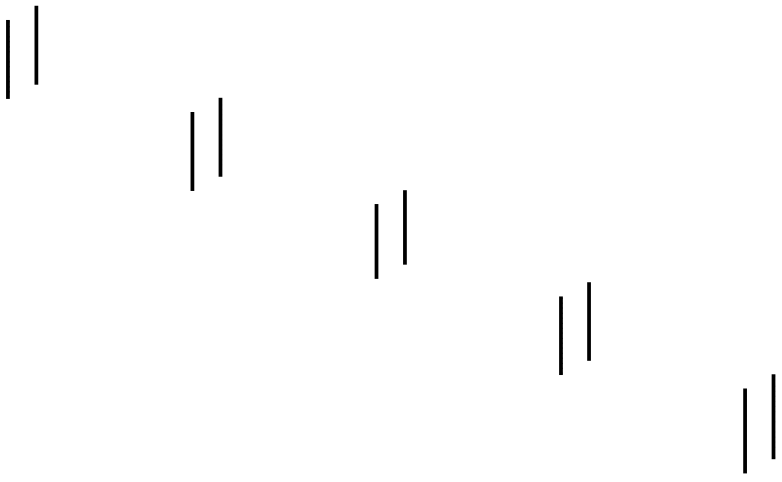
Group: Stubovi
Beam Results: max M3= 3630 / min M3= -134 kNm

Load 10: dt+12.3



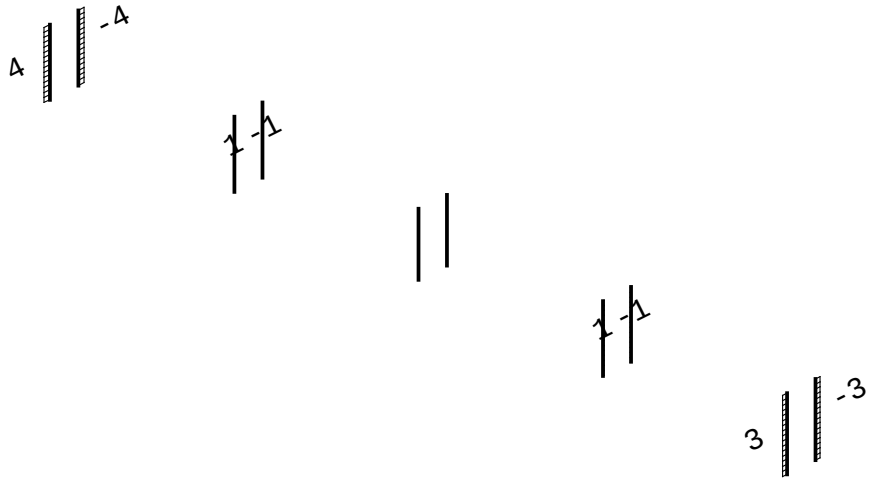
Group: Stubovi
Beam Results: max M2= 20 / min M2= -20 kNm

Load 10: dt+12.3



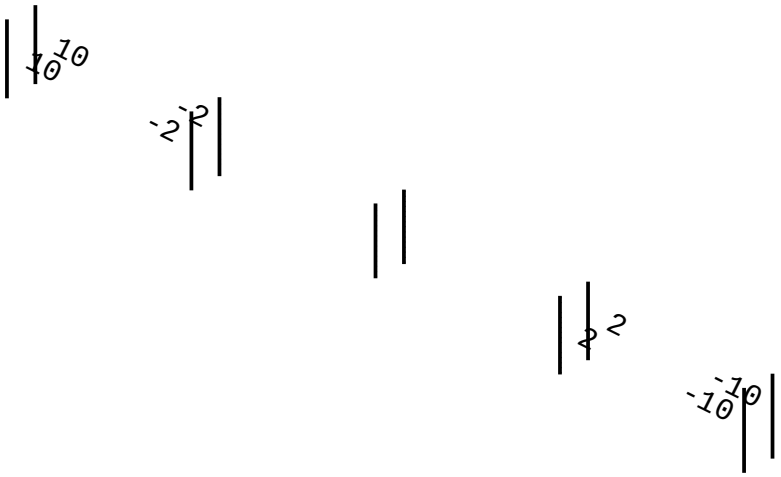
Group: Stubovi
Beam Results: max M1= 10 / min M1= -10 kNm

Load 10: dt+12.3



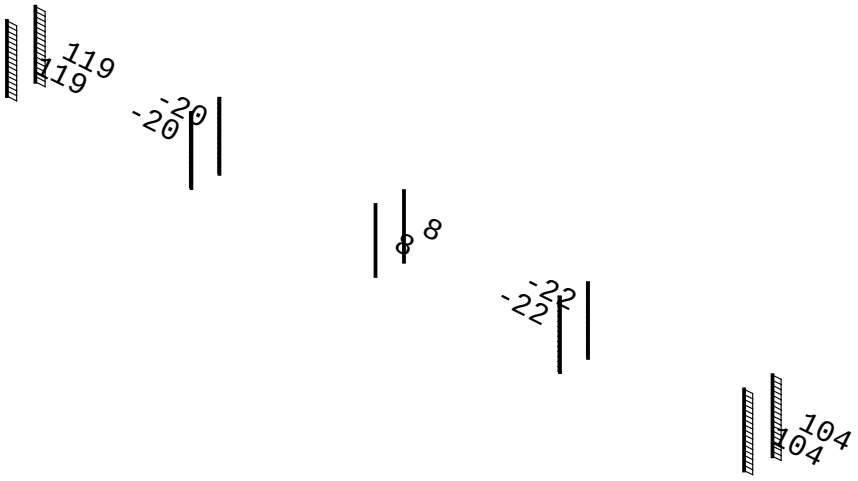
Group: Stubovi
Beam Results: max V3= 7 / min V3= -7 kN

Load 10: dt+12.3



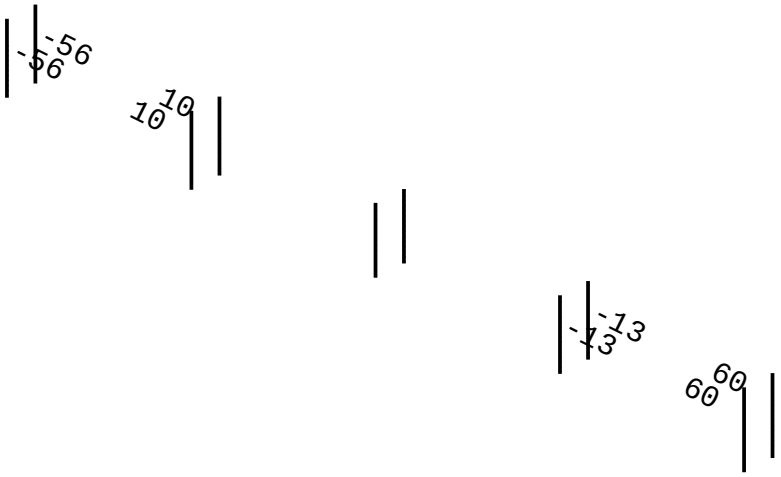
Group: Stubovi
Beam Results: max V2= 172 / min V2= -207 kN

Load 10: dt+12.3



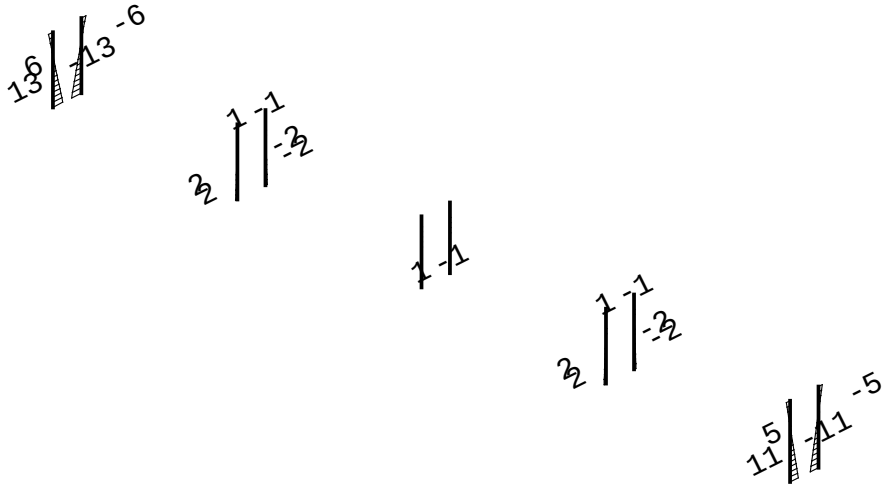
Group: Stubovi
Beam Results: max N1= 119 / min N1= -22 kN

Load 11: dt-8



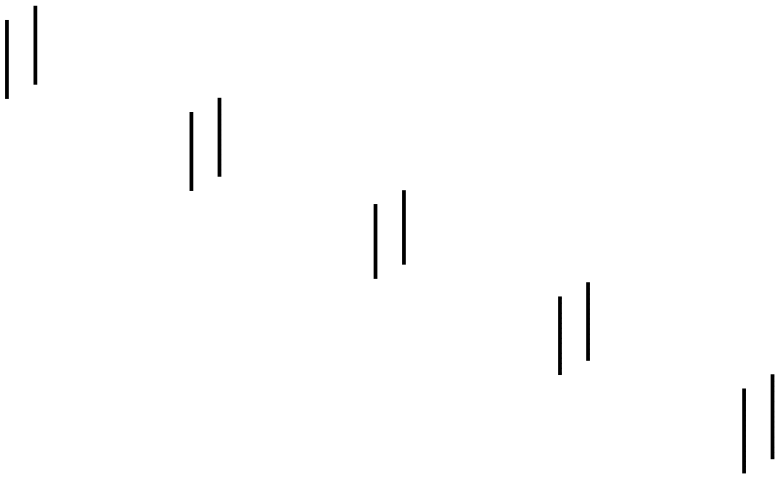
Group: Stubovi
Beam Results: max M3= 87 / min M3= -2361 kNm

Load 11: dt-8



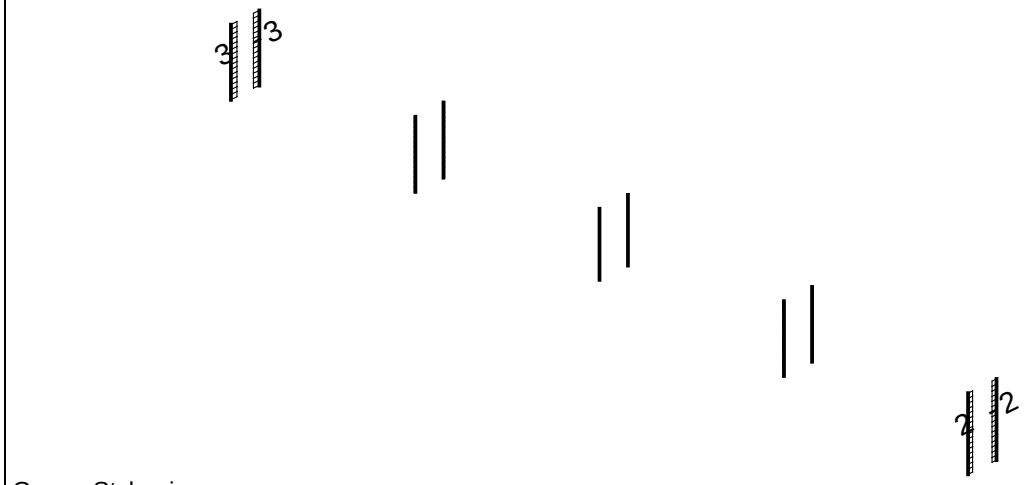
Group: Stubovi
Beam Results: max M2= 13 / min M2= -13 kNm

Load 11: dt-8



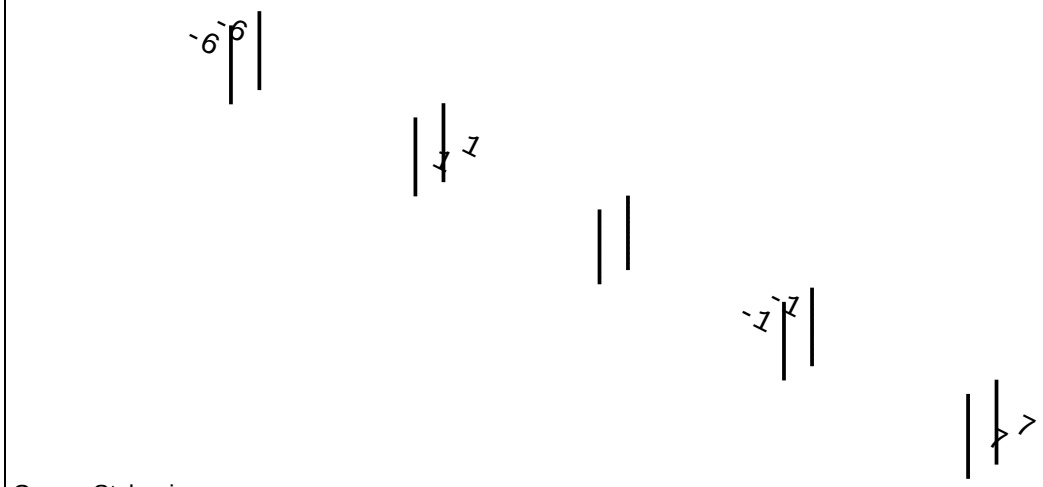
Group: Stubovi
Beam Results: max M1= 6 / min M1= -6 kNm

Load 11: dt-8



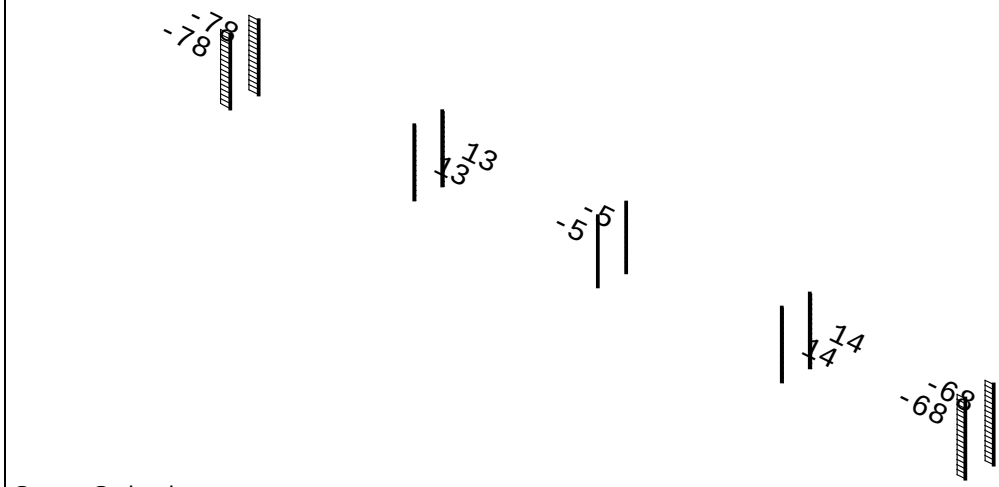
Group: Stubovi
Beam Results: max V3= 4 / min V3= -4 kN

Load 11: dt-8



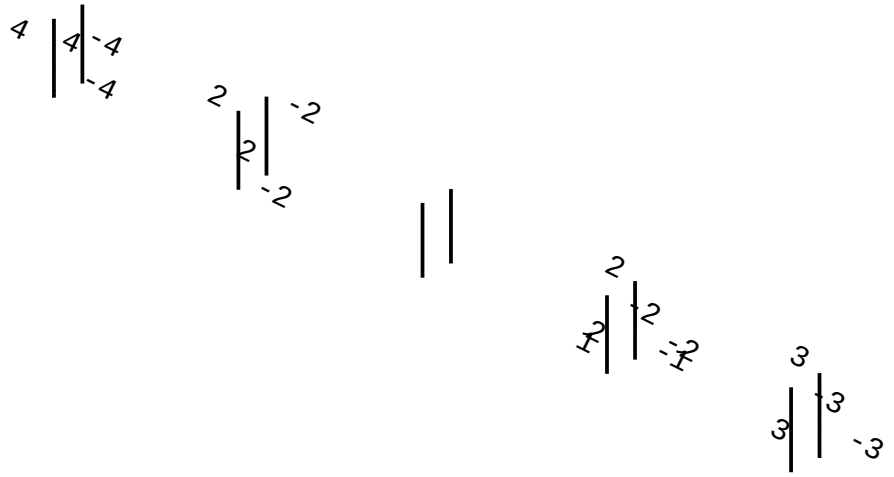
Group: Stubovi
Beam Results: max V2= 135 / min V2= -112 kN

Load 11: dt-8



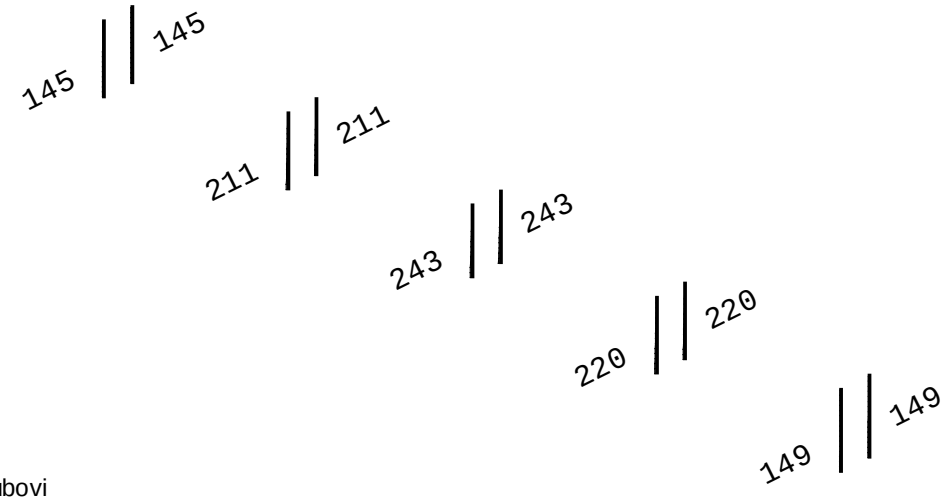
Group: Stubovi
Beam Results: max N1= 14 / min N1= -78 kN

Load 12: Vetar



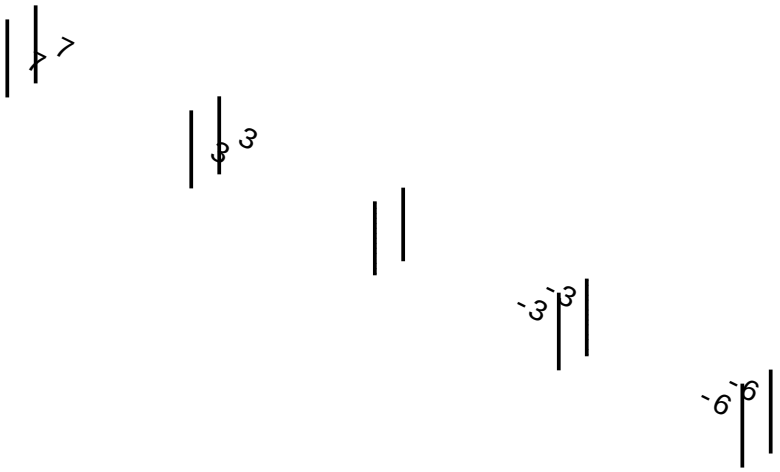
Group: Stubovi
Beam Results: max M3= 230 / min M3= -230 kNm

Load 12: Vetar



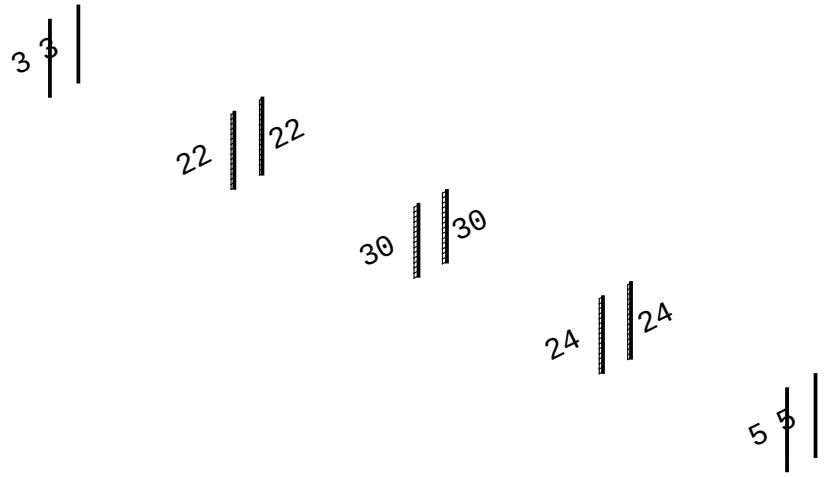
Group: Stubovi
Beam Results: max M2= 243 / min M2= -980 kNm

Load 12: Vetar



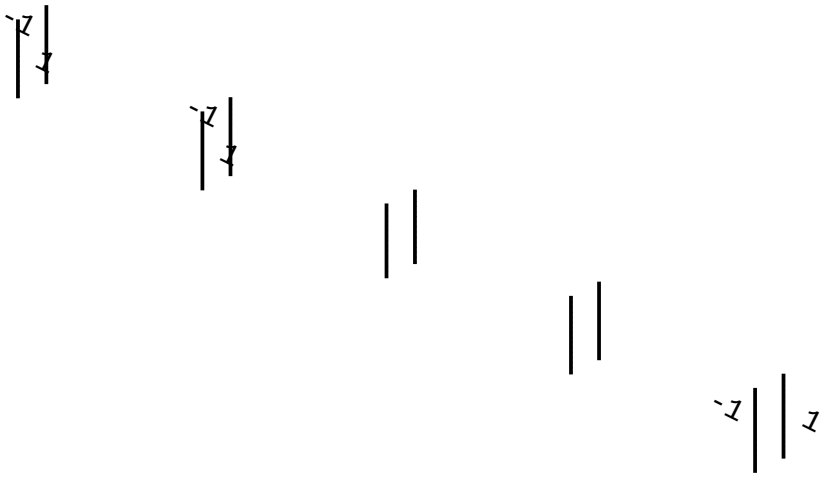
Group: Stubovi
Beam Results: max M1= 98 / min M1= -151 kNm

Load 12: Vetar



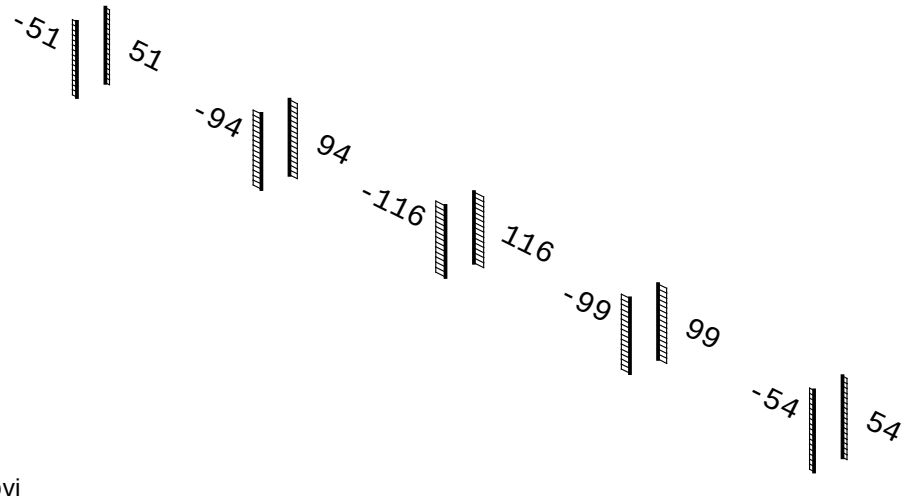
Group: Stubovi
Beam Results: max V3= 65 / min V3= -64 kN

Load 12: Vetar



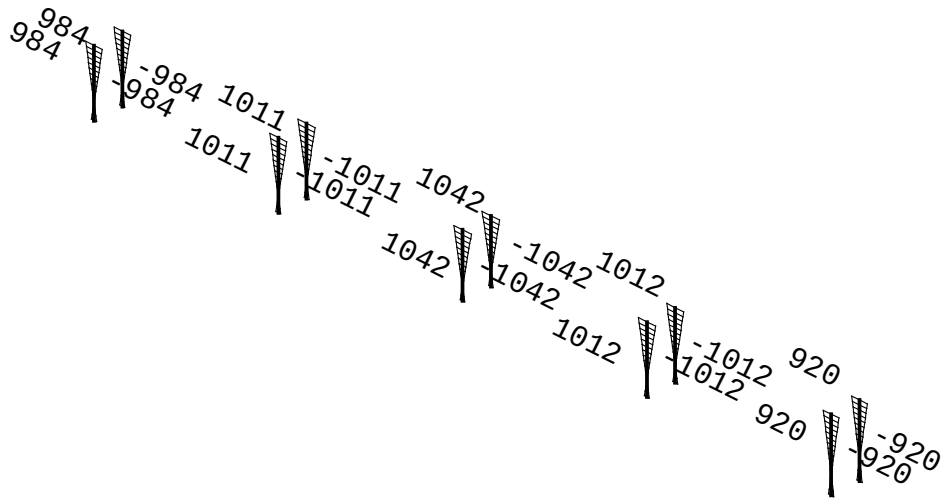
Group: Stubovi
Beam Results: max V2= 155 / min V2= -1 kN

Load 12: Vetar



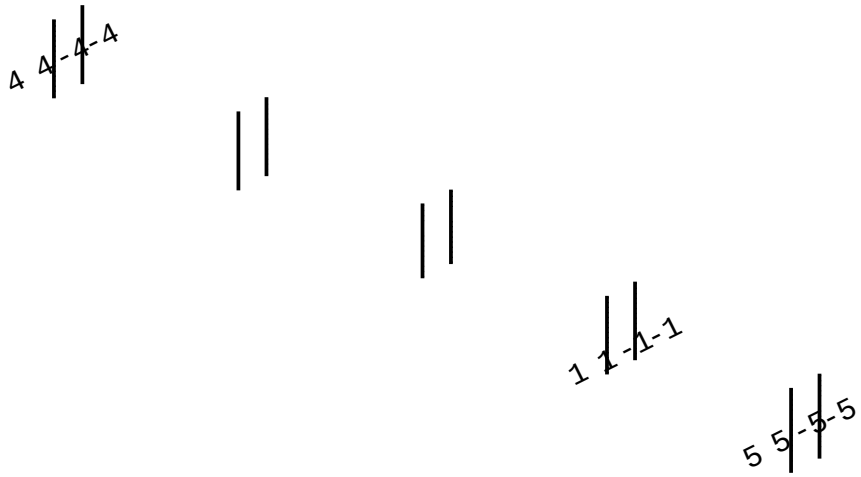
Group: Stubovi
Beam Results: max N1= 116 / min N1= -116 kN

Load 13: Sx



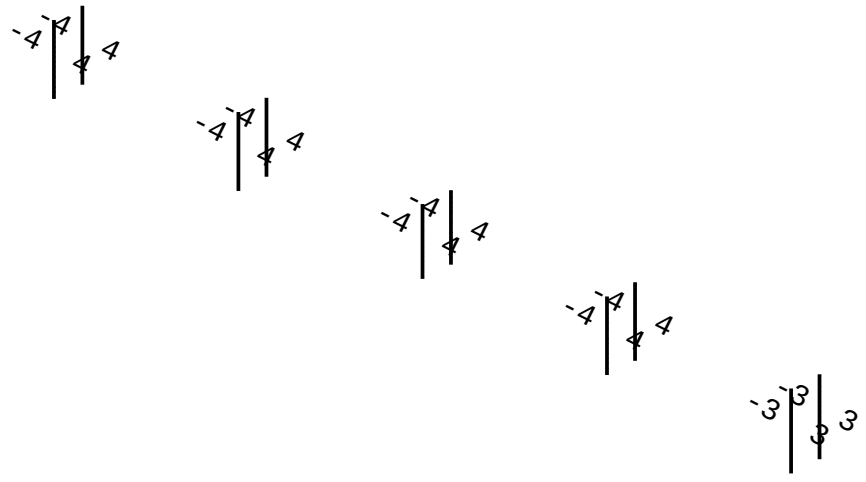
Group: Stubovi
Beam Results: max M3= 1155 / min M3= -1155 kNm

Load 13: Sx



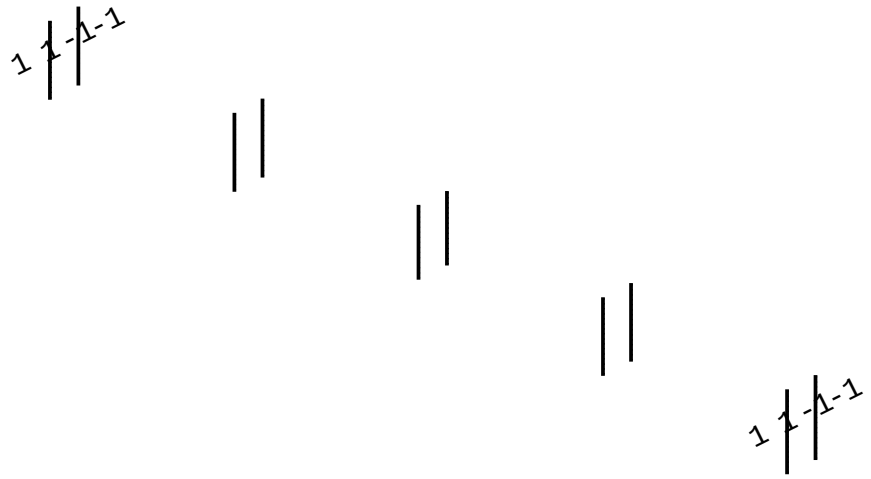
Group: Stubovi
Beam Results: max M2= 244 / min M2= -244 kNm

Load 13: Sx



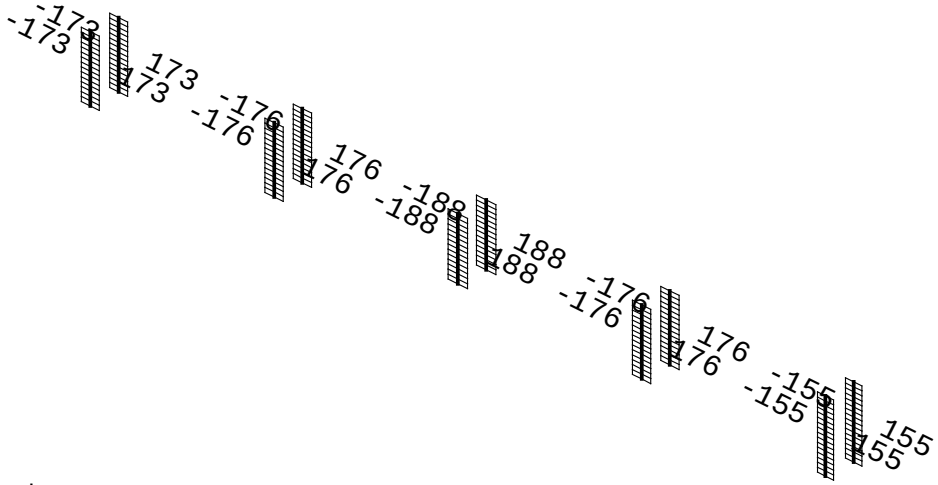
Group: Stubovi
Beam Results: max M1= 208 / min M1= -208 kNm

Load 13: Sx



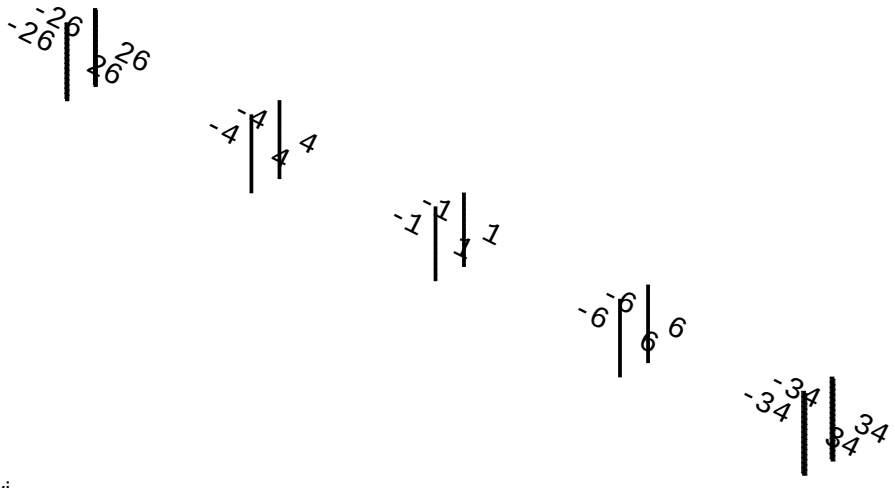
Group: Stubovi
Beam Results: max V3= 129 / min V3= -129 kN

Load 13: Sx



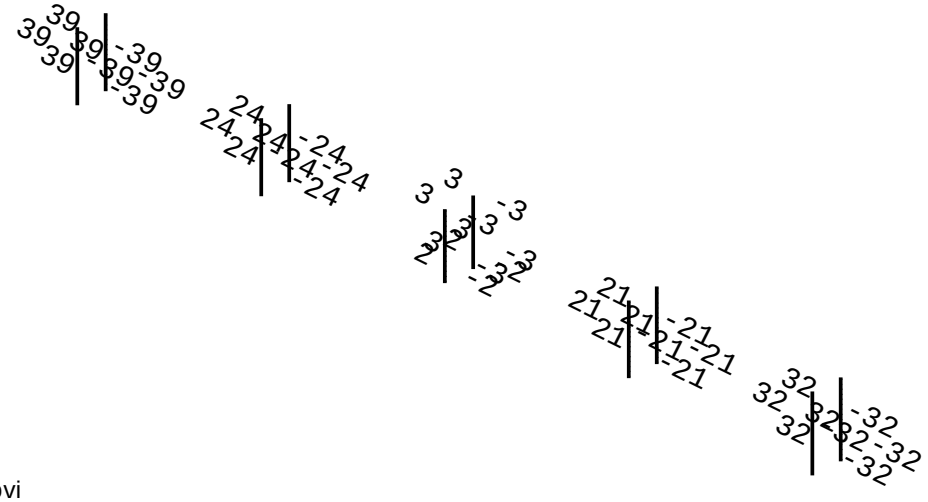
Group: Stubovi
Beam Results: max V2= 188 / min V2= -188 kN

Load 13: Sx



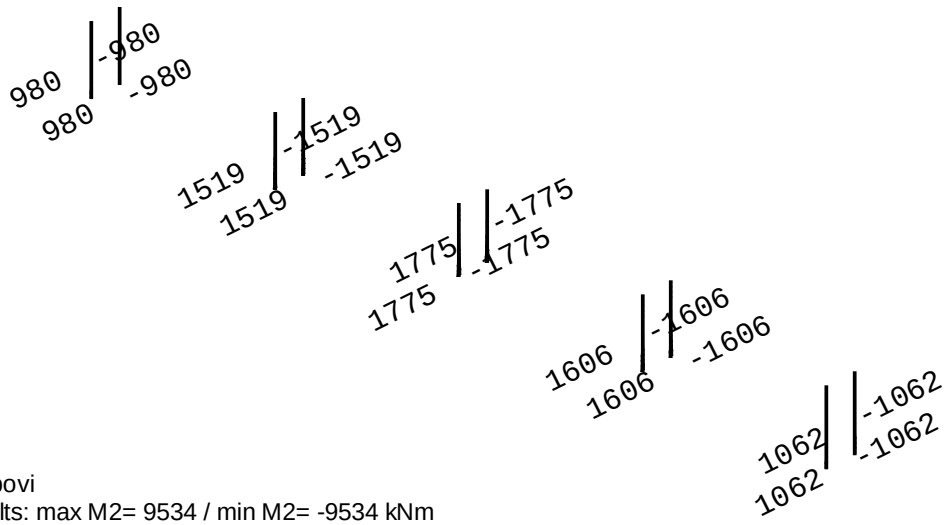
Group: Stubovi
Beam Results: max N1= 140 / min N1= -140 kN

Load 14: Sy



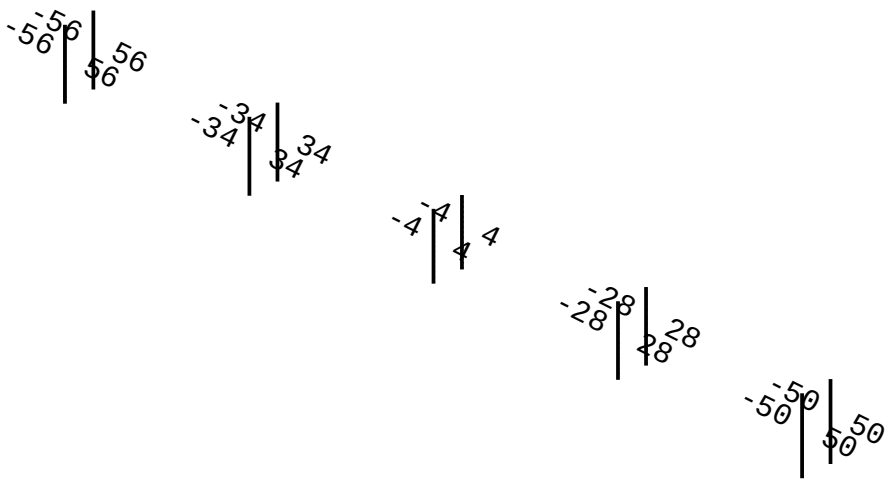
Group: Stubovi
Beam Results: max M3= 1862 / min M3= -1862 kNm

Load 14: Sy



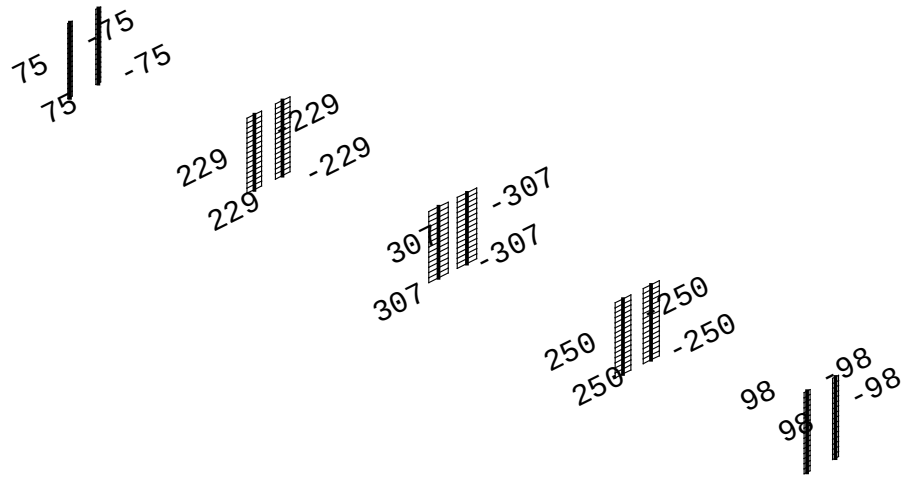
Group: Stubovi
Beam Results: max M2= 9534 / min M2= -9534 kNm

Load 14: Sy



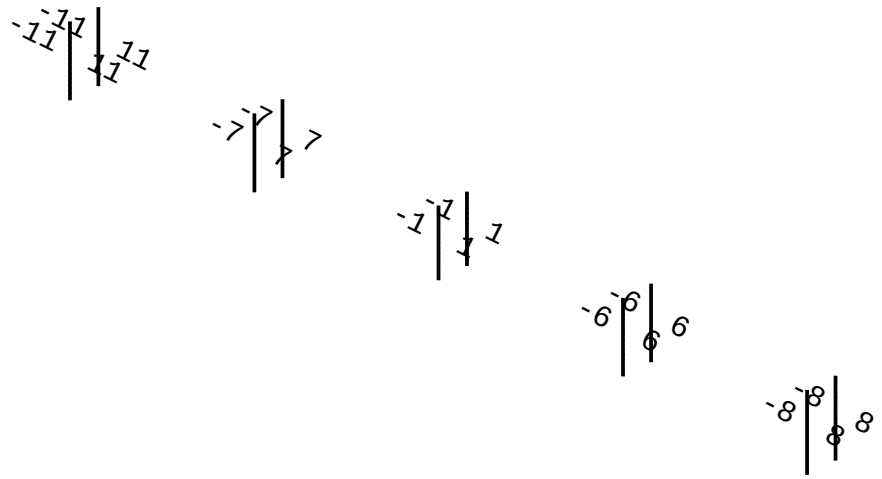
Group: Stubovi
Beam Results: max M1= 899 / min M1= -899 kNm

Load 14: Sy



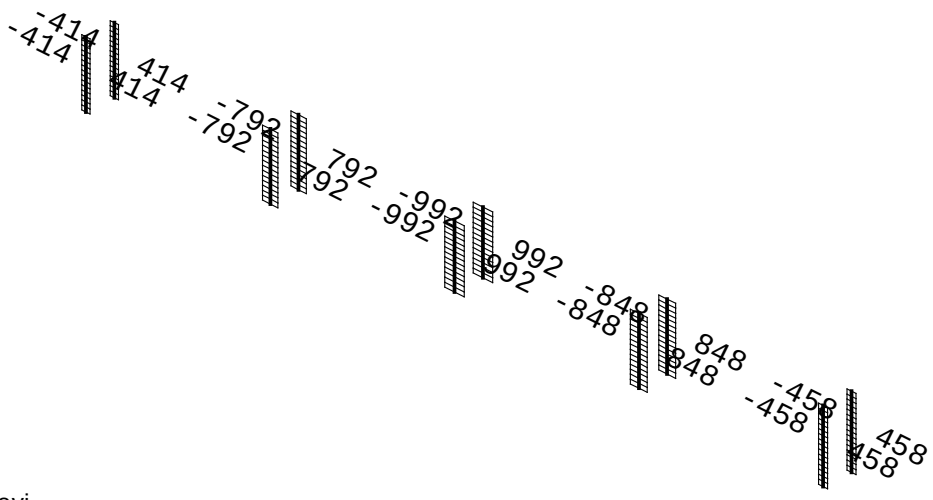
Group: Stubovi
Beam Results: max V3= 309 / min V3= -309 kN

Load 14: Sy



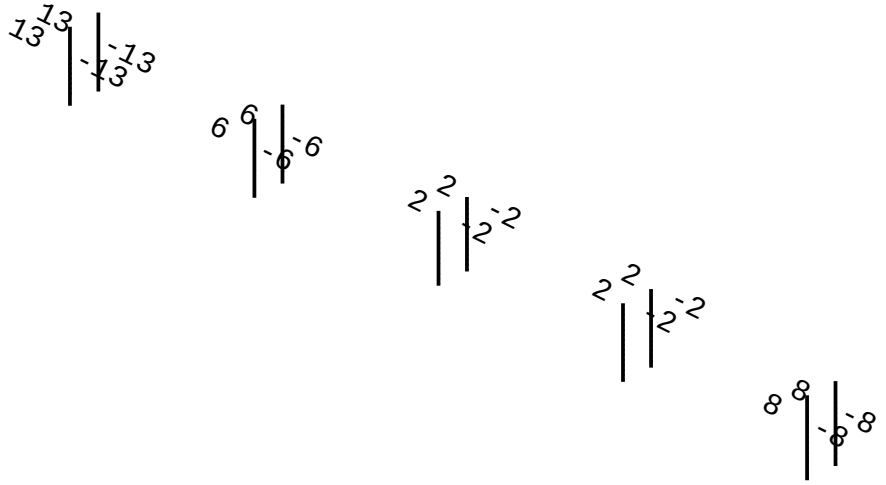
Group: Stubovi
Beam Results: max V2= 1328 / min V2= -1328 kN

Load 14: Sy



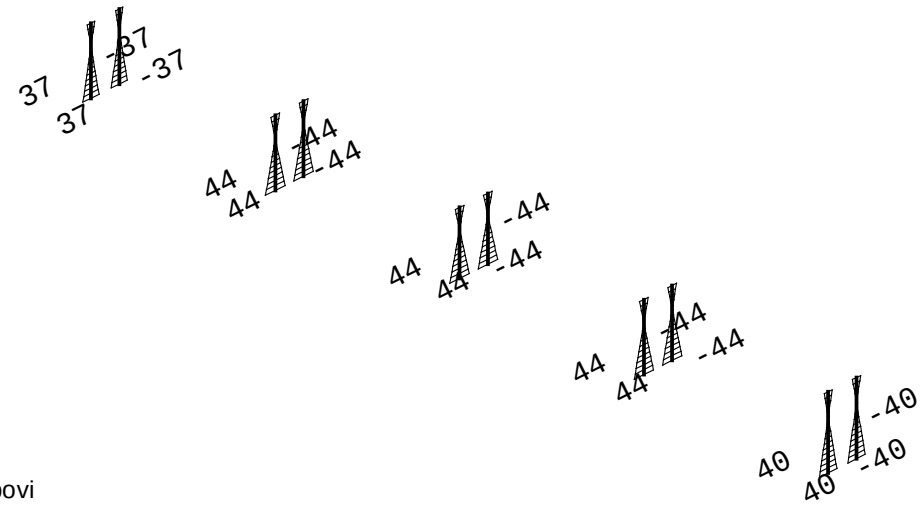
Group: Stubovi
Beam Results: max N1= 992 / min N1= -992 kN

Load 15: Sz



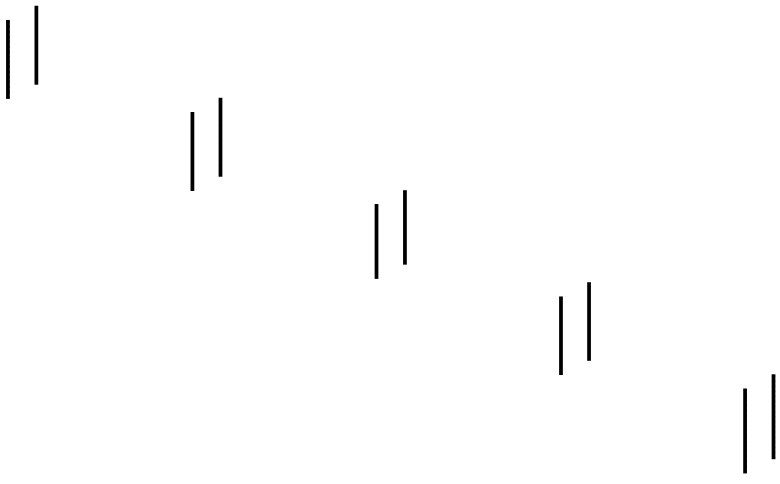
Group: Stubovi
Beam Results: max M3= 293 / min M3= -293 kNm

Load 15: Sz



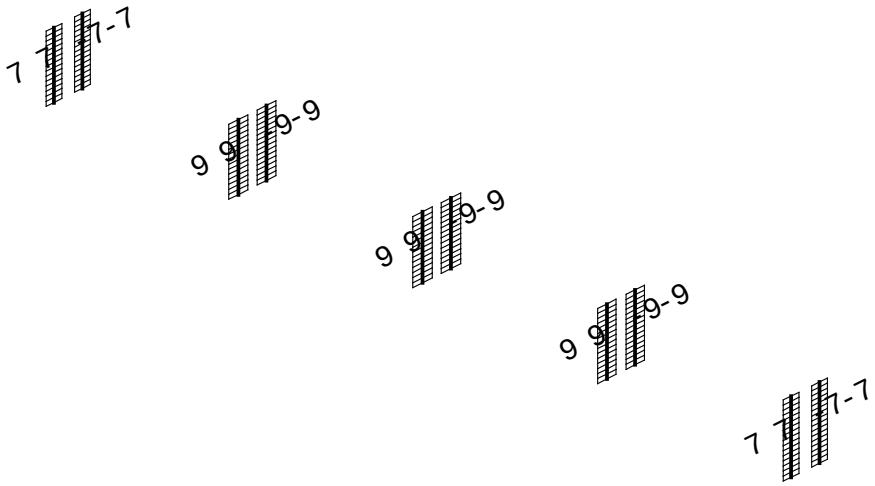
Group: Stubovi
Beam Results: max M2= 44 / min M2= -44 kNm

Load 15: Sz



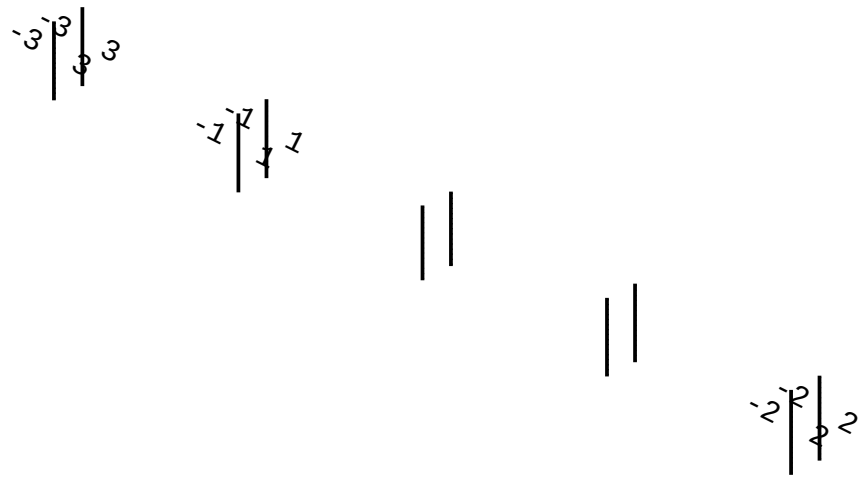
Group: Stubovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 15: Sz



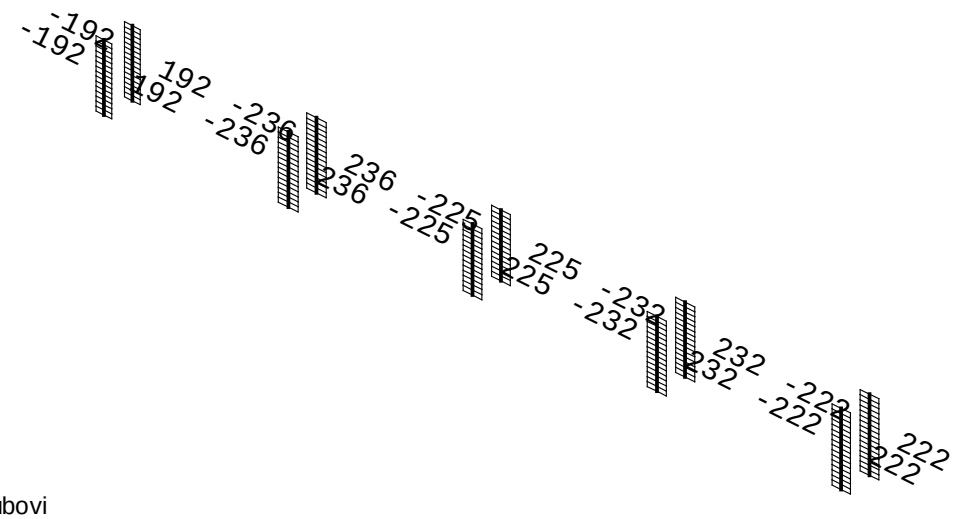
Group: Stubovi
Beam Results: max V3= 9 / min V3= -9 kN

Load 15: Sz



Group: Stubovi
Beam Results: max V2= 162 / min V2= -162 kN

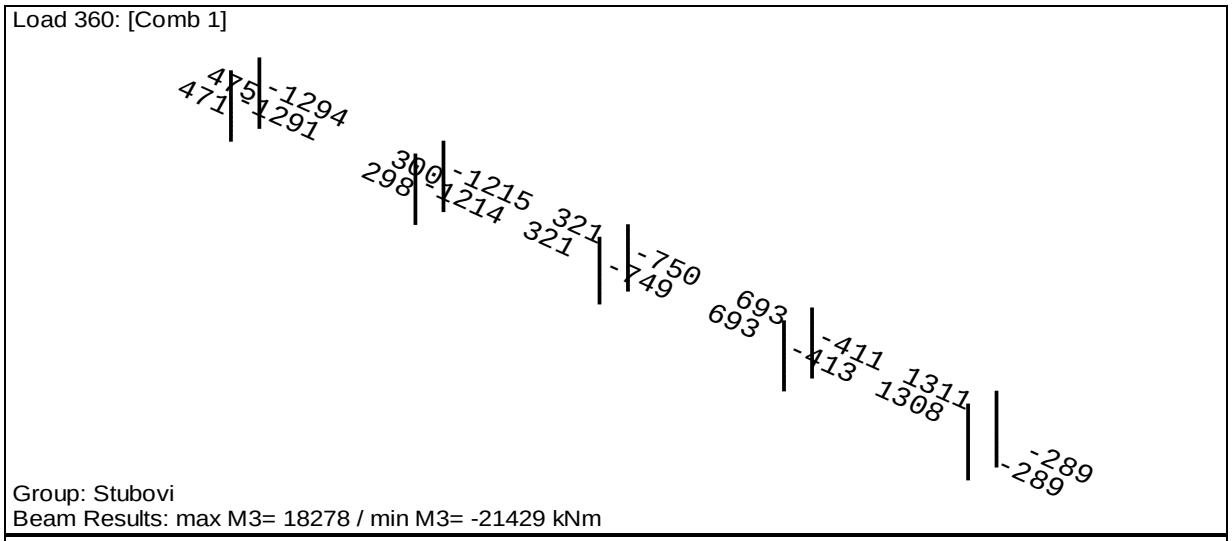
Load 15: Sz

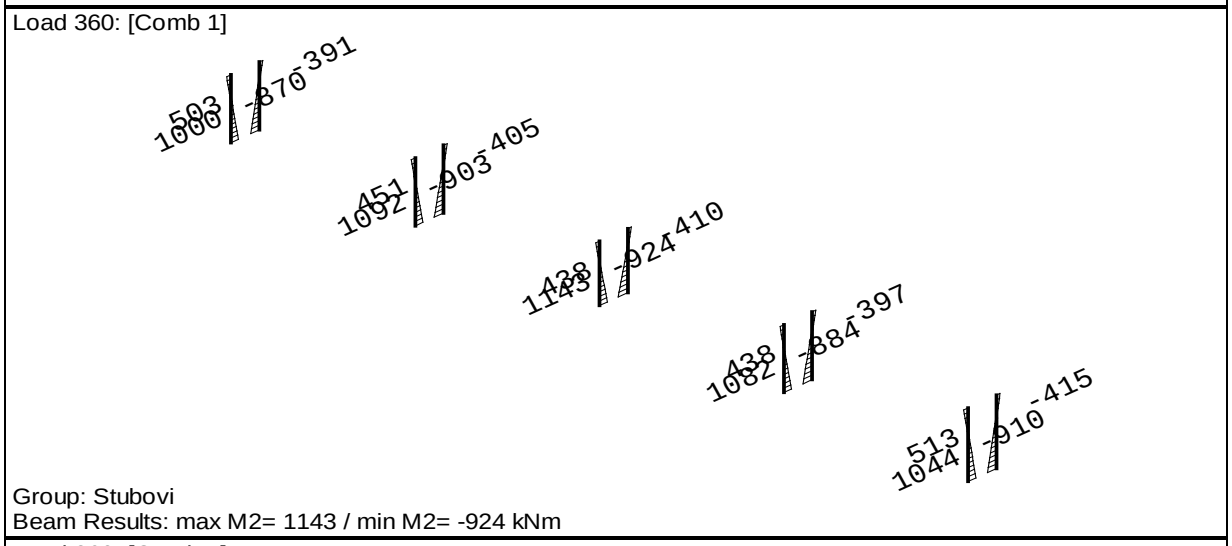


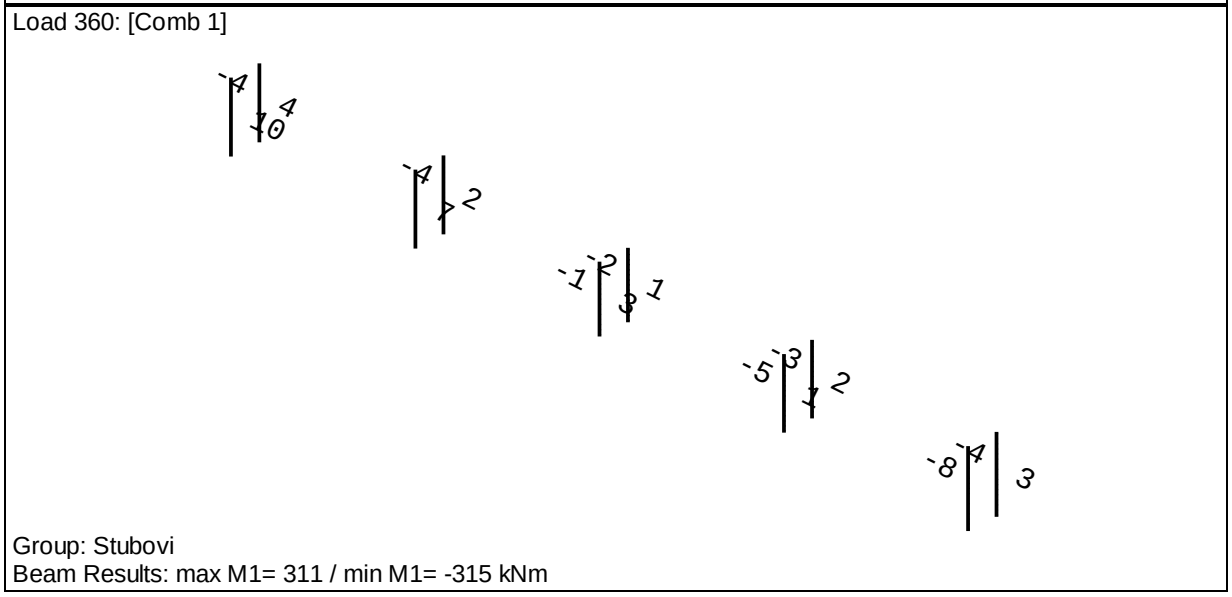
Group: Stubovi
Beam Results: max N1= 236 / min N1= -236 kN

4.6.2.3 **Димензионисање /** Reinforcement design

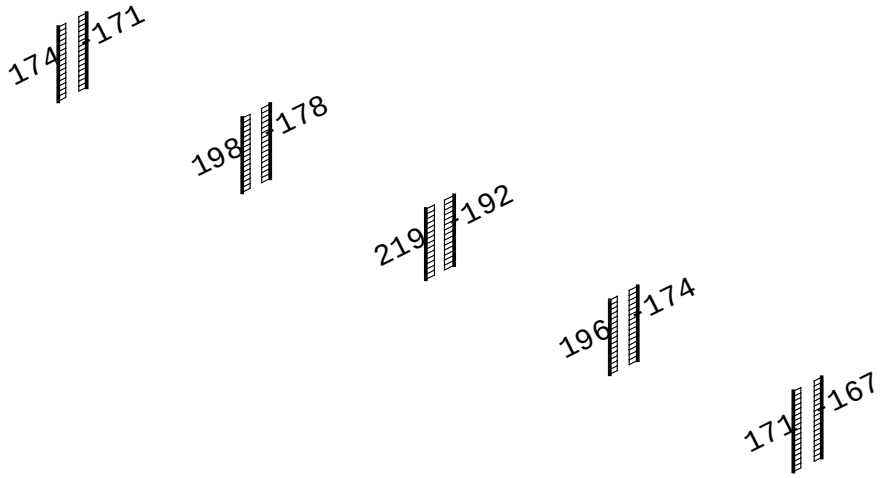
Comb 1





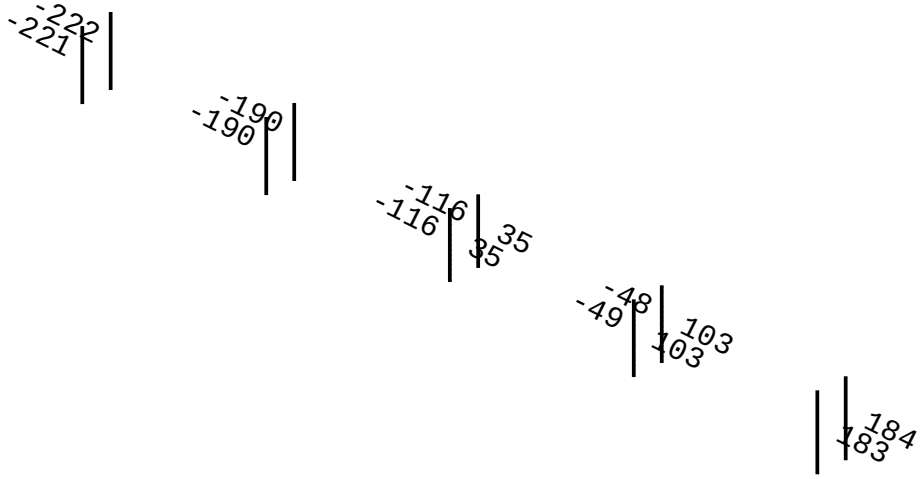


Load 360: [Comb 1]



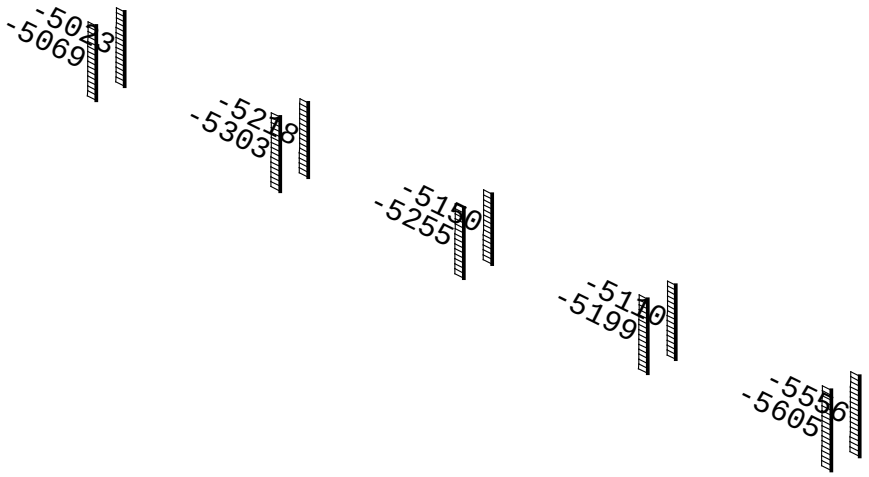
Group: Stubovi
Beam Results: max V3= 219 / min V3= -192 kN

Load 360: [Comb 1]



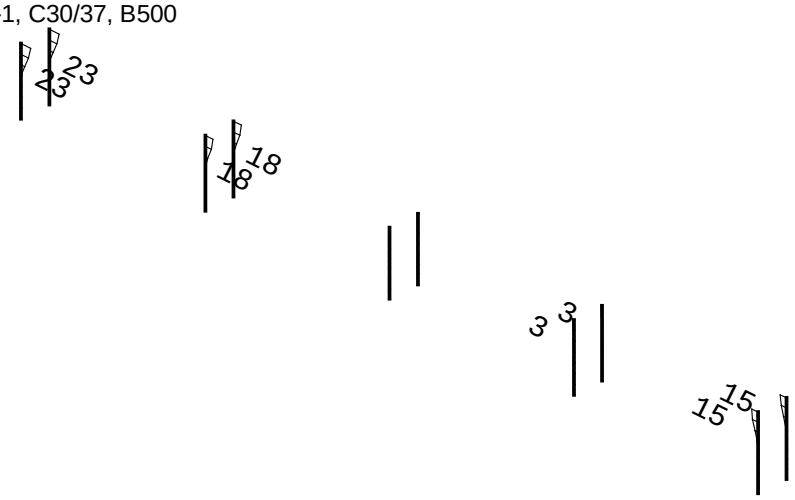
Group: Stubovi
Beam Results: max V2= 5648 / min V2= -6160 kN

Load 360: [Comb 1]



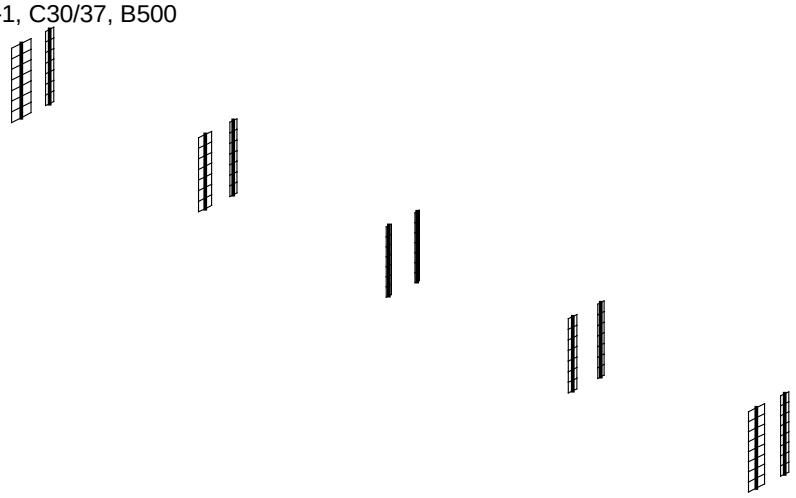
Group: Stubovi
Beam Results: max N1= 548 / min N1= -5605 kN

Governing load: 16-35
SRPS EN 1992-1-1, C30/37, B500



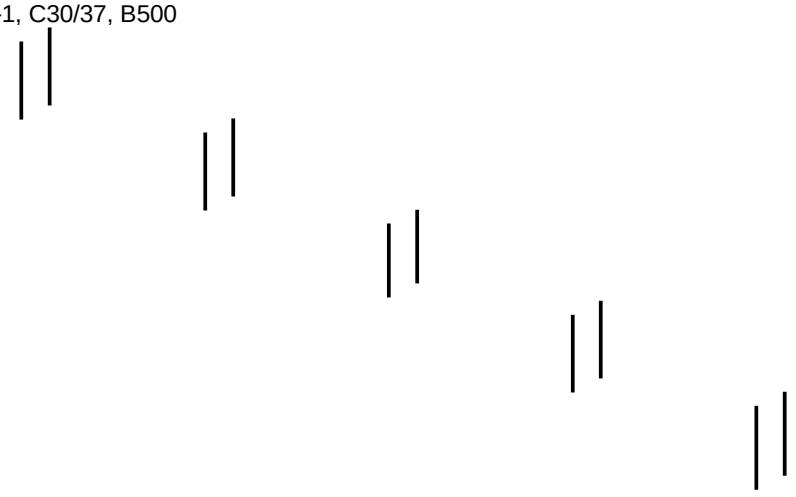
Group: Stubovi
Beam reinforcement: Aa2/Aa1

Governing load: 16-35
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa3/Aa4

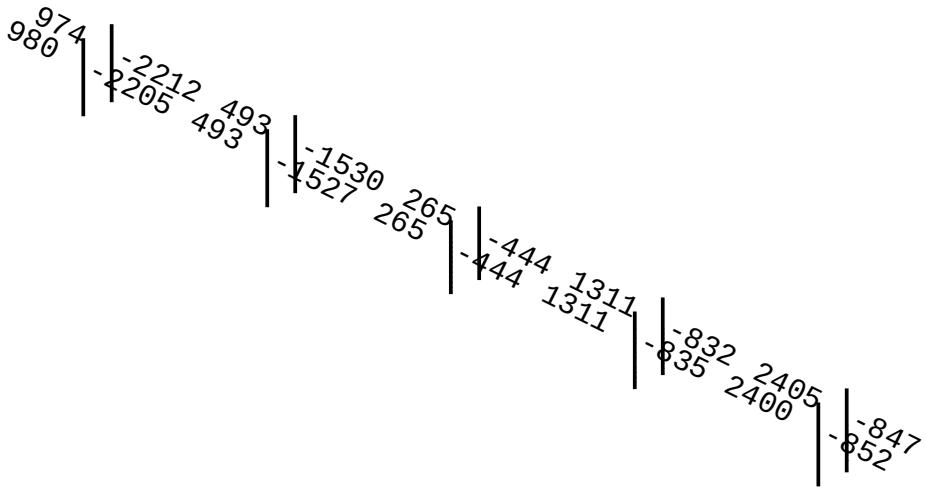
Governing load: 16-35
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa,br

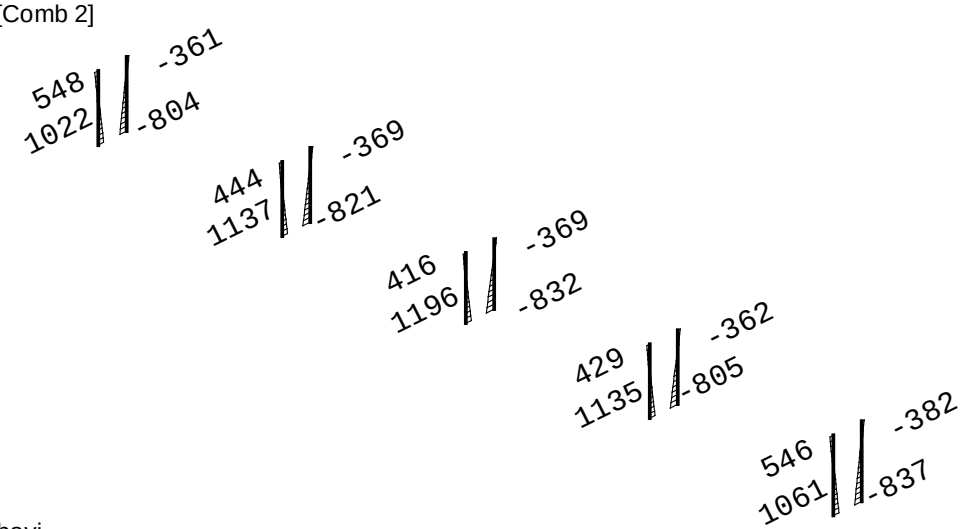
Comb 2

Load 361: [Comb 2]



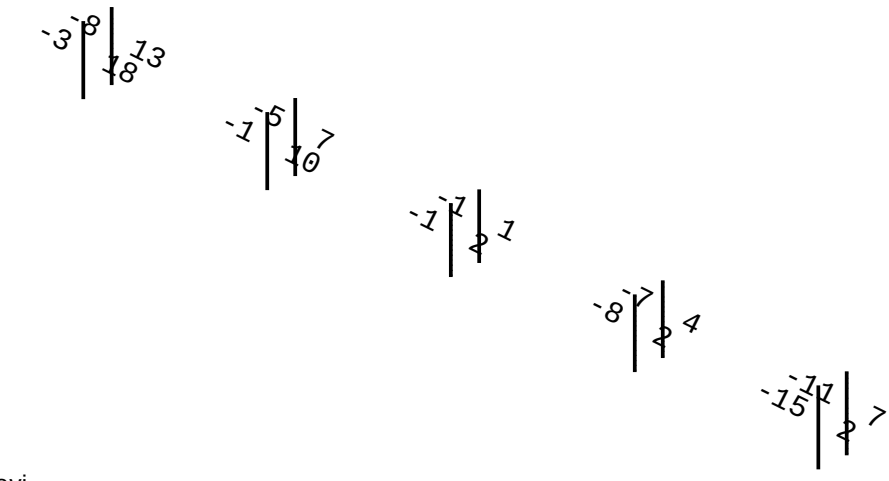
Group: Stubovi
Beam Results: max M3= 18121 / min M3= -23069 kNm

Load 361: [Comb 2]



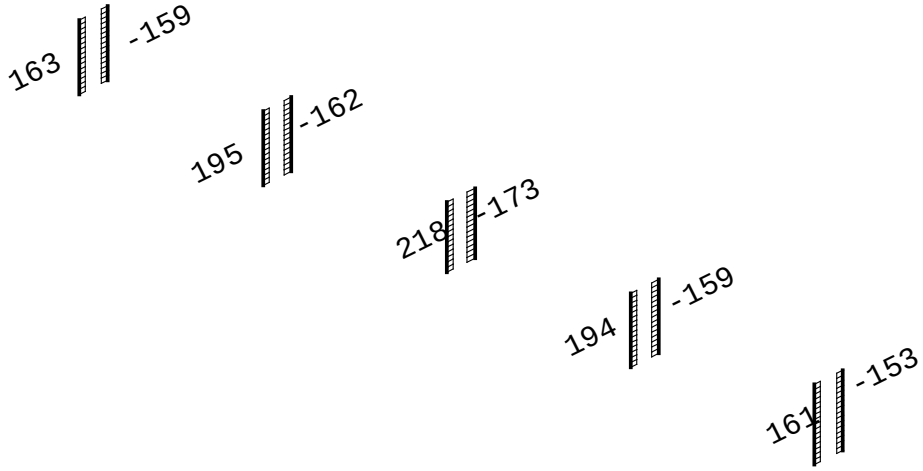
Group: Stubovi
Beam Results: max M2= 1196 / min M2= -1470 kNm

Load 361: [Comb 2]



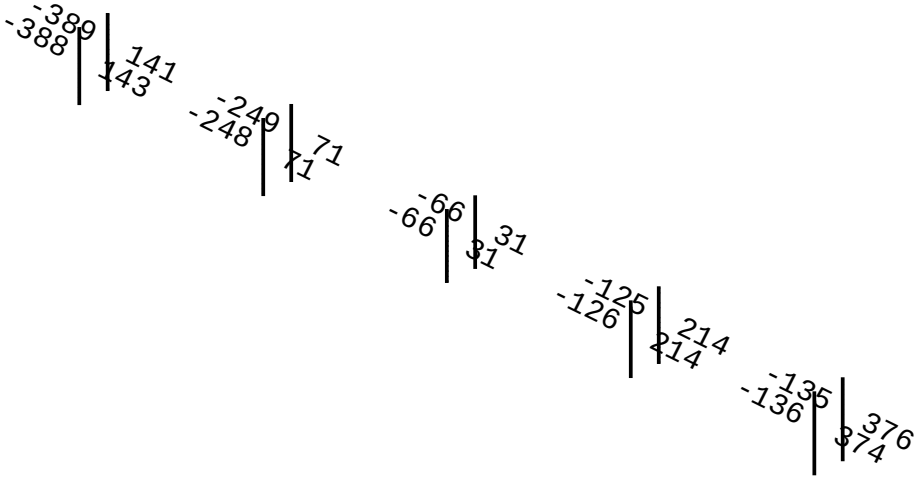
Group: Stubovi
Beam Results: max M1= 516 / min M1= -523 kNm

Load 361: [Comb 2]



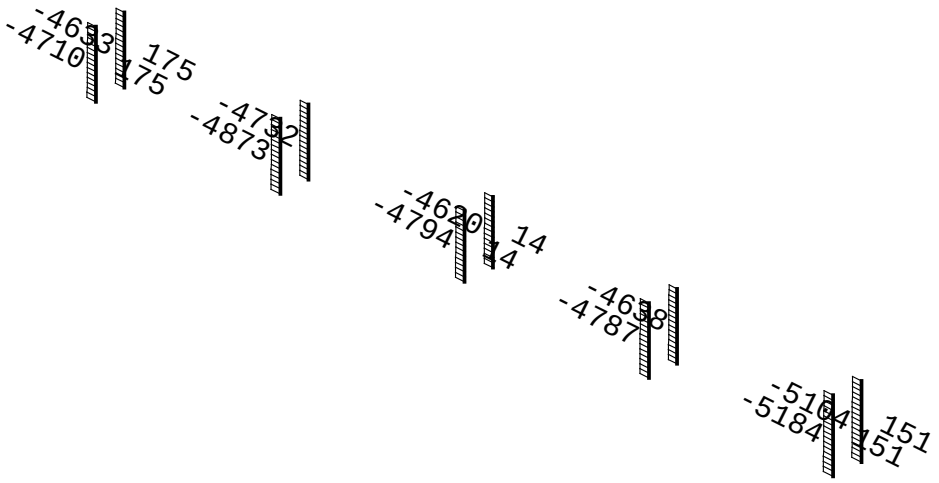
Group: Stubovi
Beam Results: max V3= 260 / min V3= -258 kN

Load 361: [Comb 2]

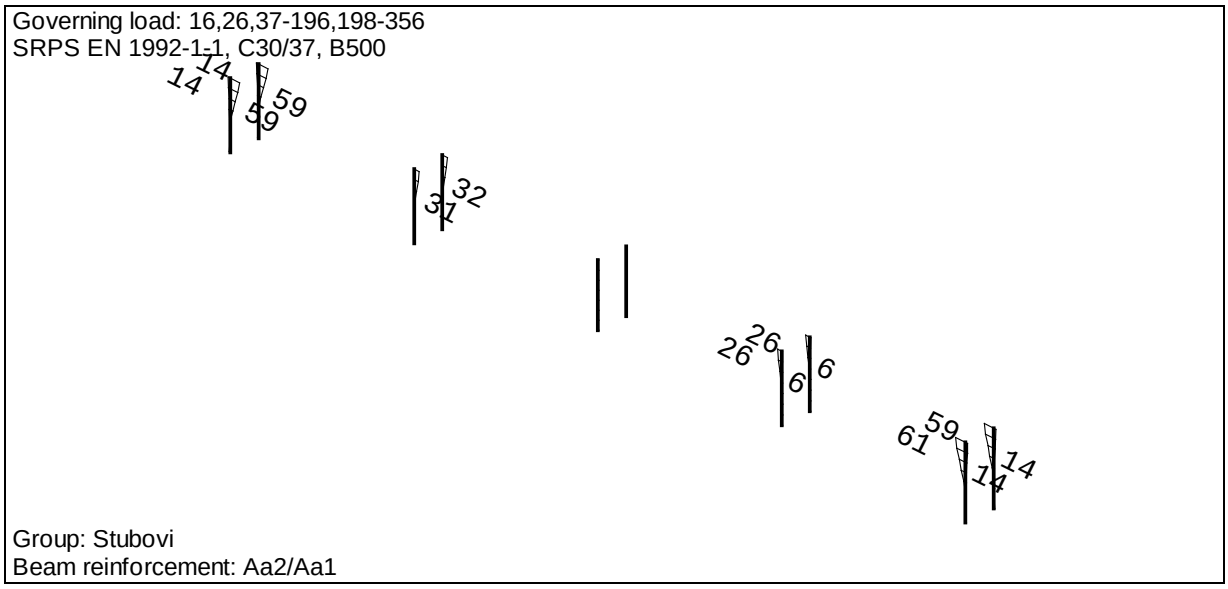


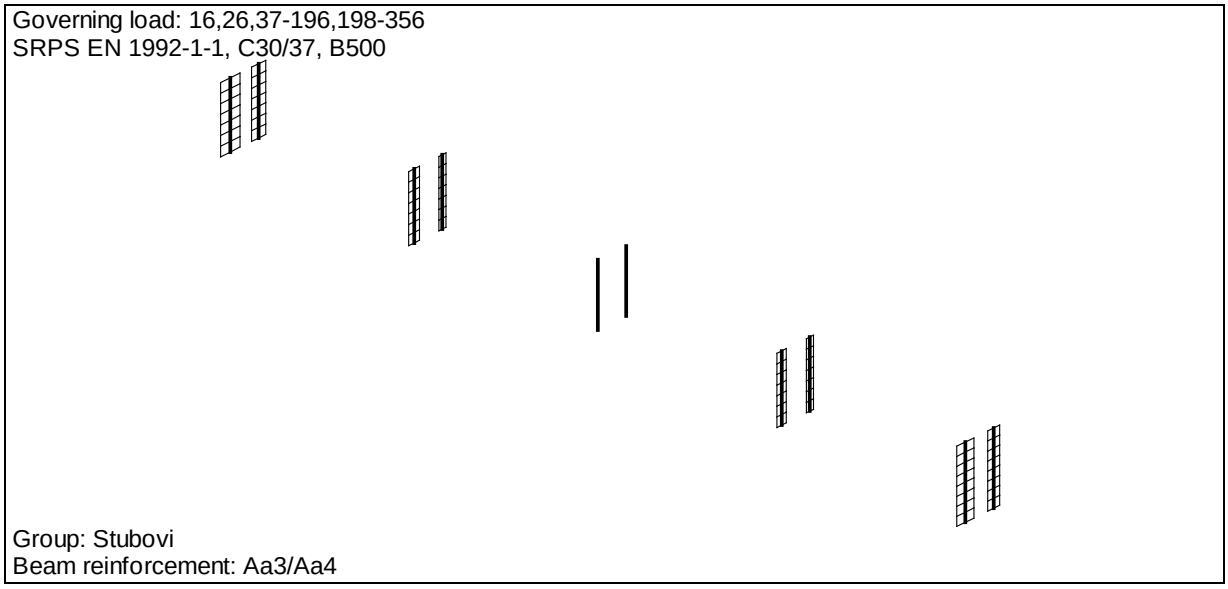
Group: Stubovi
Beam Results: max V2= 5062 / min V2= -5569 kN

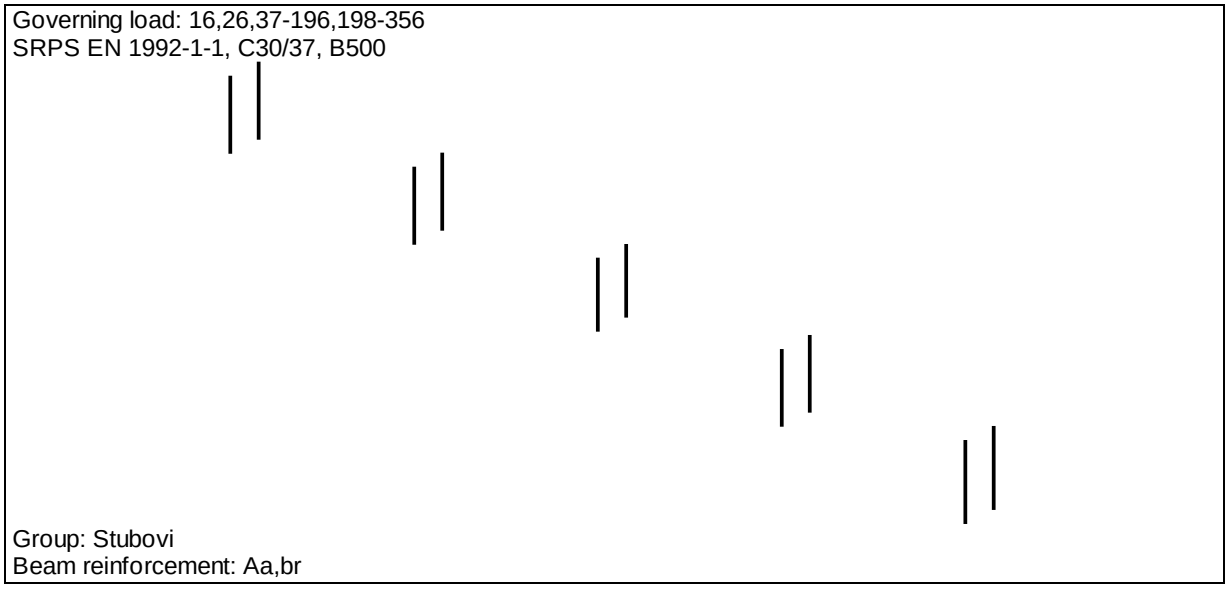
Load 361: [Comb 2]



Group: Stubovi
Beam Results: max N1= 1114 / min N1= -5184 kN

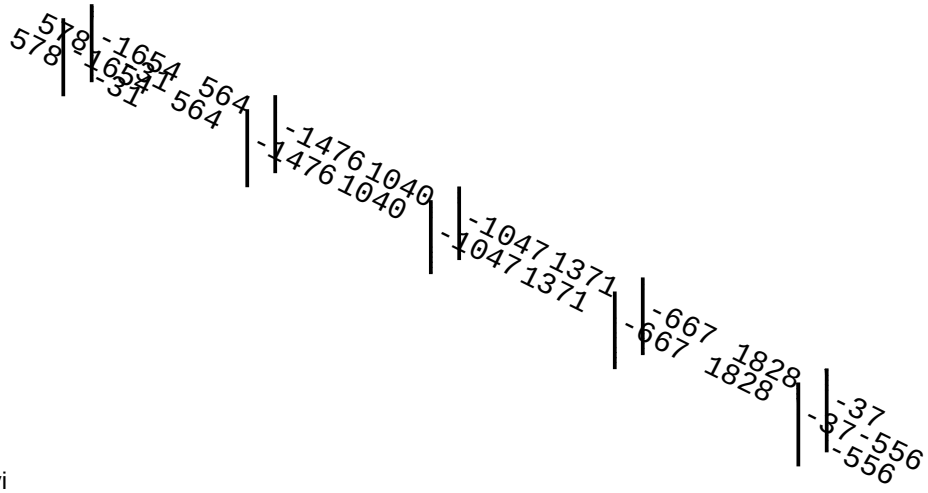

Governing load: 16,26,37-196,198-356
SRPS EN 1992-1-1, C30/37, B500
14
14
59
59
37
32
26
26
6
6
61
59
14
14
Group: Stubovi
Beam reinforcement: Aa2/Aa1


Governing load: 16,26,37-196,198-356
SRPS EN 1992-1-1, C30/37, B500
Group: Stubovi
Beam reinforcement: Aa3/Aa4


Governing load: 16,26,37-196,198-356
SRPS EN 1992-1-1, C30/37, B500
Group: Stubovi
Beam reinforcement: Aa,br

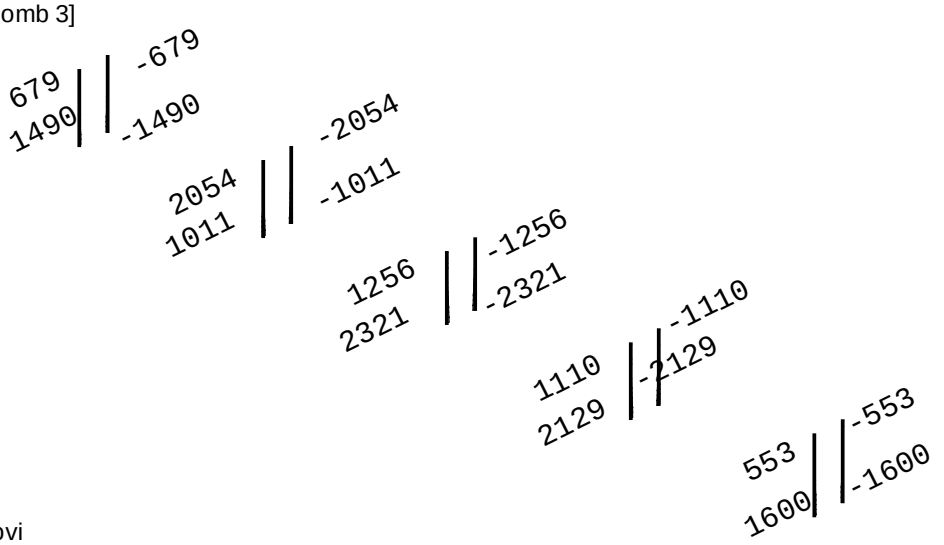
Comb 3

Load 362: [Comb 3]



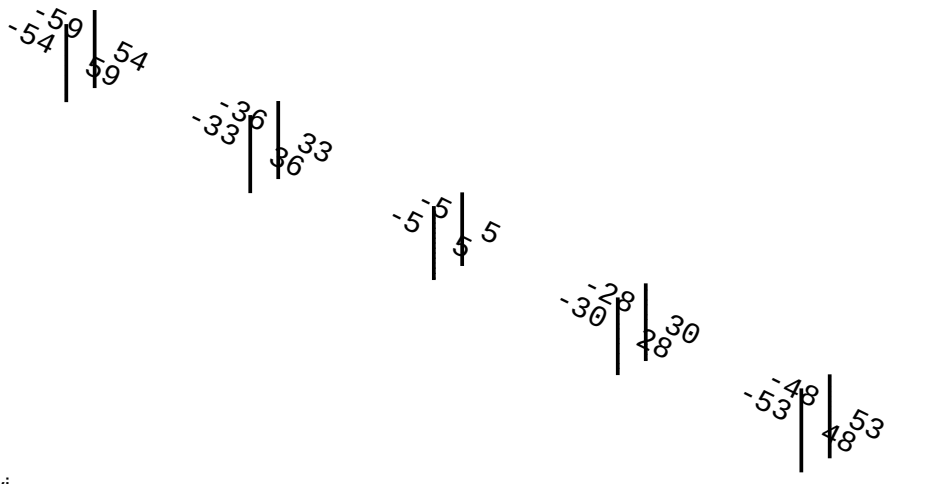
Group: Stubovi
Beam Results: max M3= 8472 / min M3= -12804 kNm

Load 362: [Comb 3]



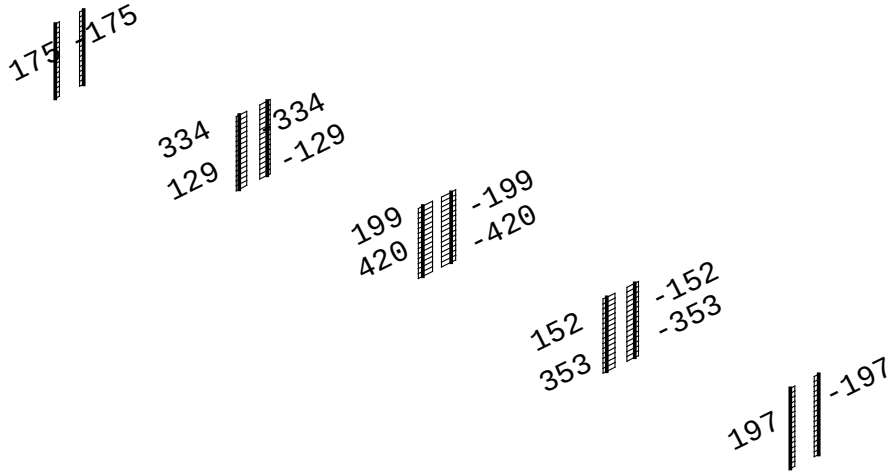
Group: Stubovi
Beam Results: max M2= 9534 / min M2= -9534 kNm

Load 362: [Comb 3]



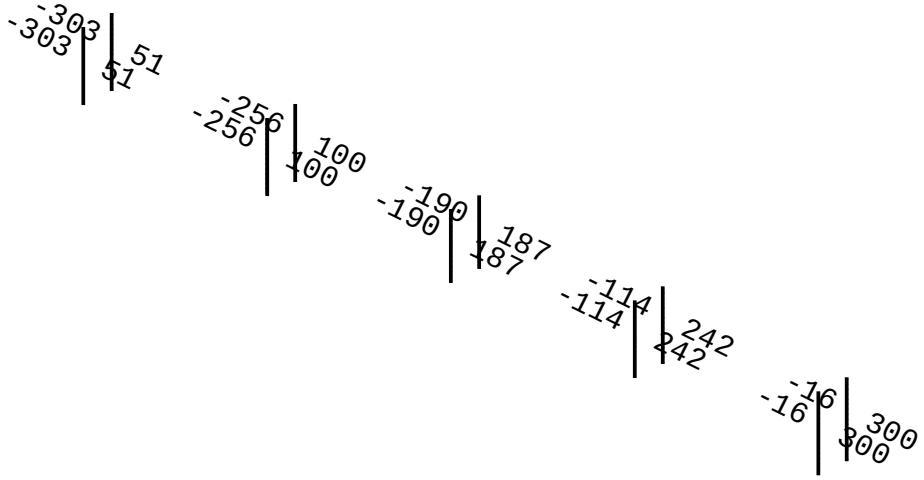
Group: Stubovi
Beam Results: max M1= 899 / min M1= -899 kNm

Load 362: [Comb 3]



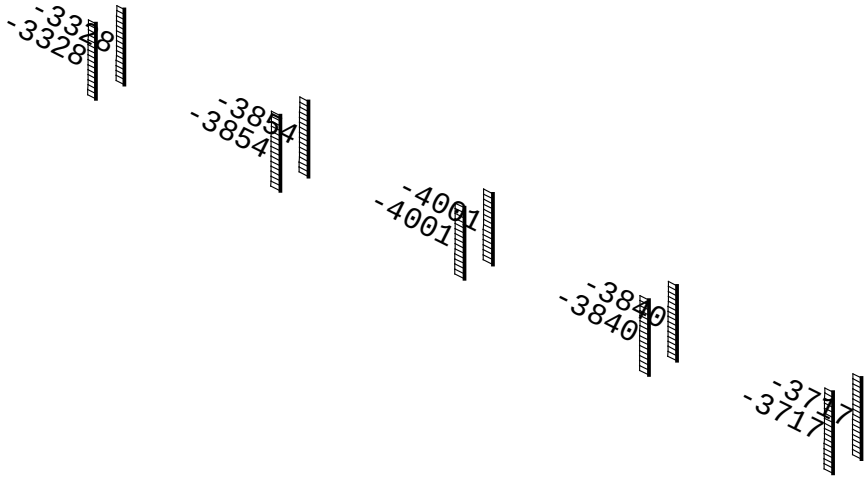
Group: Stubovi
Beam Results: max V3= 420 / min V3= -420 kN

Load 362: [Comb 3]



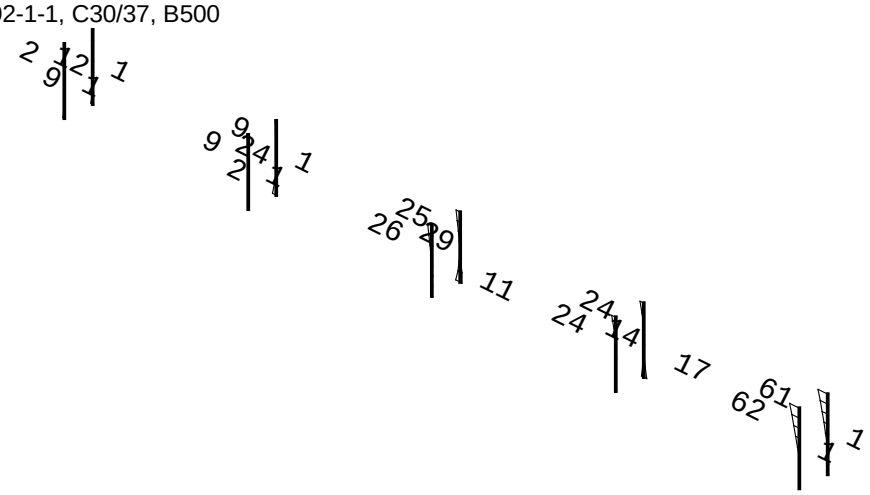
Group: Stubovi
Beam Results: max V2= 2918 / min V2= -3184 kN

Load 362: [Comb 3]



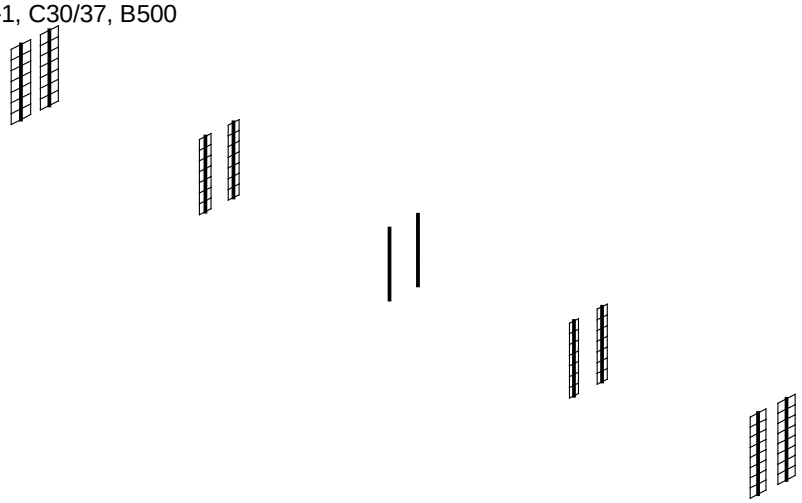
Group: Stubovi
Beam Results: max N1= 499 / min N1= -4001 kN

Governing load: 357-359
SRPS EN 1992-1-1, C30/37, B500



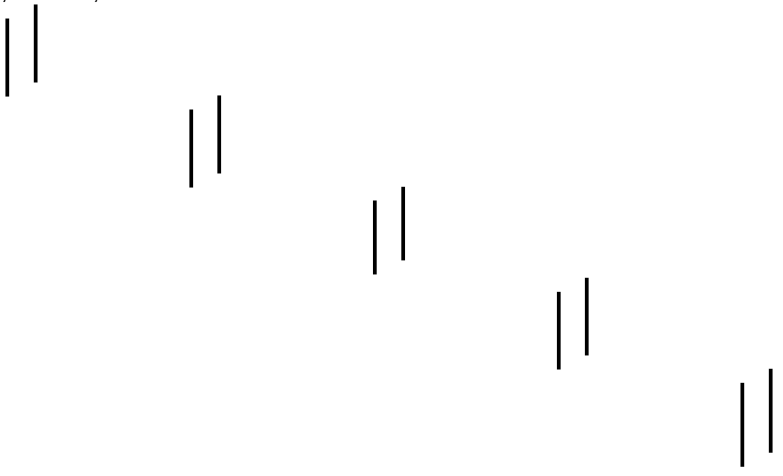
Group: Stubovi
Beam reinforcement: Aa2/Aa1

Governing load: 357-359
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa3/Aa4

Governing load: 357-359
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa,br

Потребна арматура / required reinforcement

Вертикална арматура / Vertical reinforcement

Aa1,2max = 62 cm2

Aa3,4max = 0 cm2

Смичућа арматура / Shear reinforcement

Aa = 0 cm2/m

Минимална арматура / Minimum reinforcement

160x80 cm → Ab = 12800 cm2

Aa,min = 0.003xAb = 0.003x12800 = 38.4 cm2

Aa,min = (0.15xNu)/(fyk/1.15) = (0.15x5111)/(50/1.15) = 17.63 cm2

Усвојена арматура / provided reinforcement :

Вертикална арматура / Vertical reinforcement

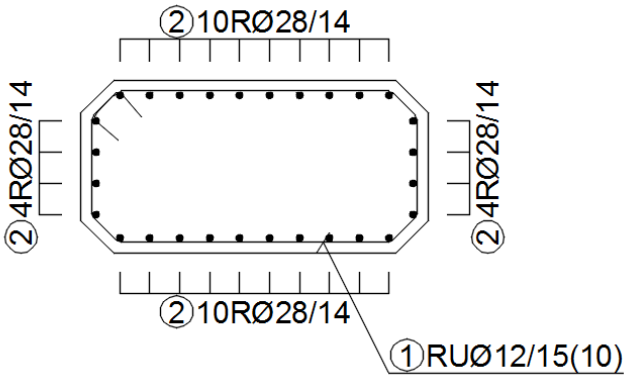
Aa1,2 → ±10Φ28 → Aa = 61.50 cm2

Aa3,4 → ±4Φ28 → Aa = 24,60 cm2

Смичућа арматура / Shear reinforcement

Aa = Φ12/10 → Aa = 11.30 cm/m → 1.0 m **На врху и дну /** at top and bottom

Aa = Φ12/15 → Aa = 7.53 cm/m → **у средини /** in the middle

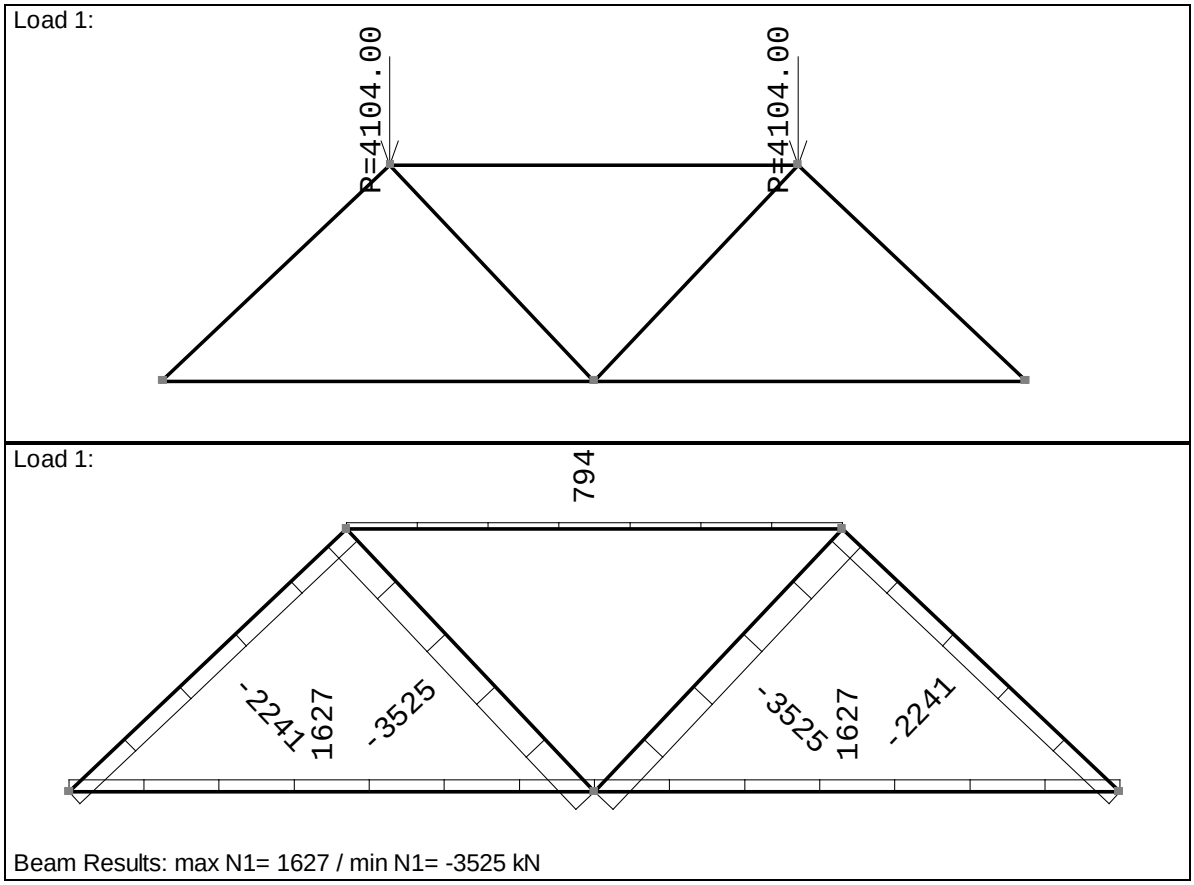


4.6.3 **Темељи /** Foundations

Користи се метод замењујуће решетке / strut-and-tie method

Меродавна је максимална аксијална сила у стубу / Maximum axial force in column e is relevant

Nd,max = 4104 kN



Потребна арматура / required reinforcement

Подужна арматура / Longitudinal reinforcement

Доња зона / Bottom zone

Z = 1627 kN

Aa = 1627/(0.6x50) = 54.23 cm2

Усвојена арматура / provided reinforcement :

12Ф25/15 → Aa = 58.89 cm2

Горња зона / Upper zone

Z = 794 kN

Aa = 794/(0.6x50) = 26.46 cm2

Усвојена арматура / provided reinforcement :

12Ф20/15 → Aa = 37.68 cm2

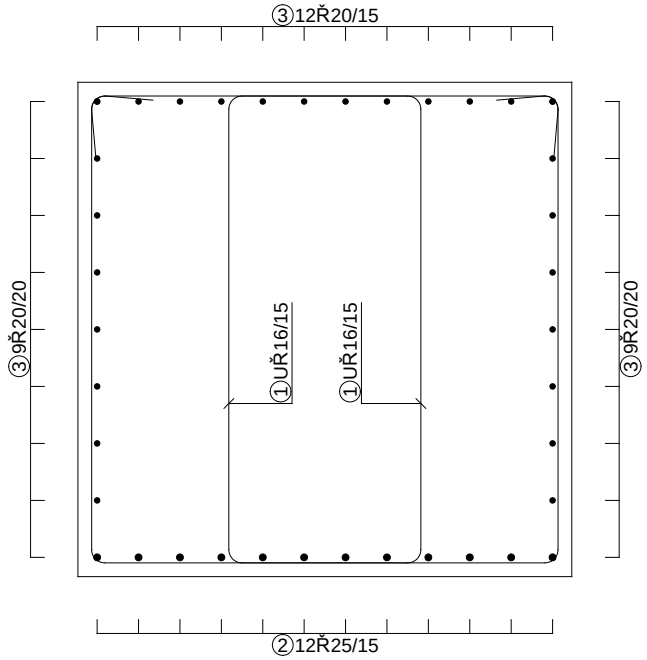
Смичућа арматура / Shear reinforcement

D1 = -3525 kN , D2 = -3525 kN

Све дијагонале су притиснуте / All diagonals are pressured

Усвојена арматура / provided reinforcement :

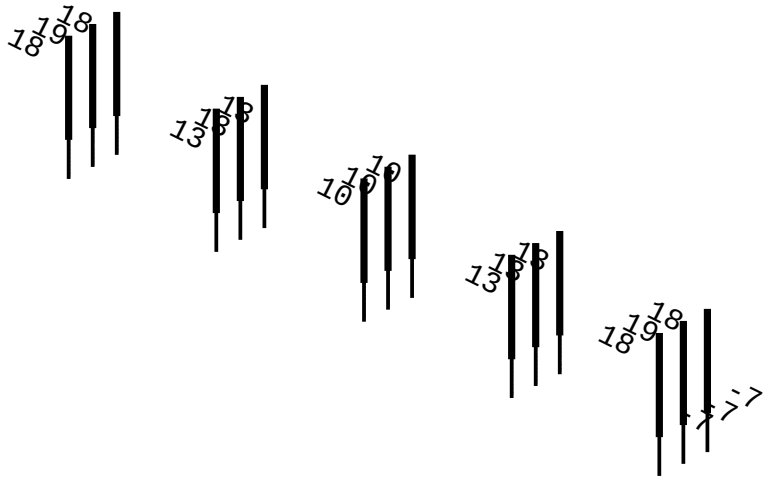
2xΦ16/15 → Aa = 13.40x2 = 26.80 cm2/m



4.6.4 **Шипови /** Piles

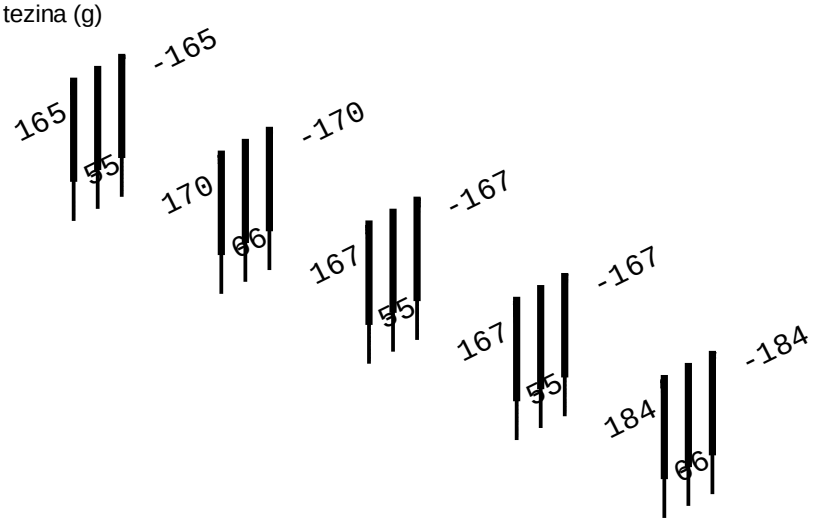
4.6.4.1 **Пресечне силе и деформације /** Internal forces and deformations

Load 1: Sopstvena tezina (g)



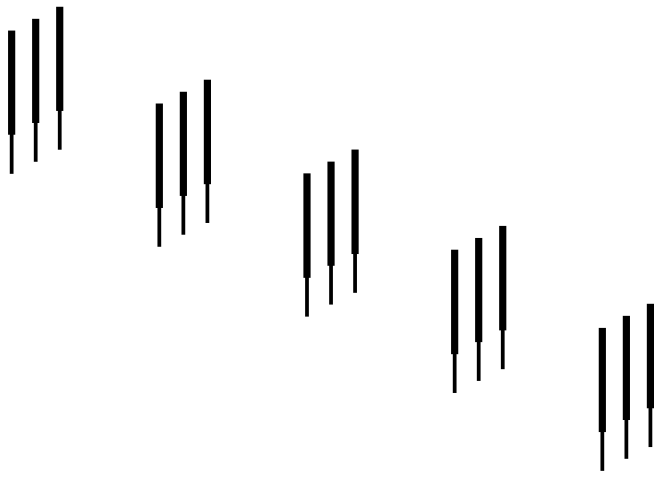
Group: Sipovi
Beam Results: max M3= 6586 / min M3= -8929 kNm

Load 1: Sopstvena tezina (g)



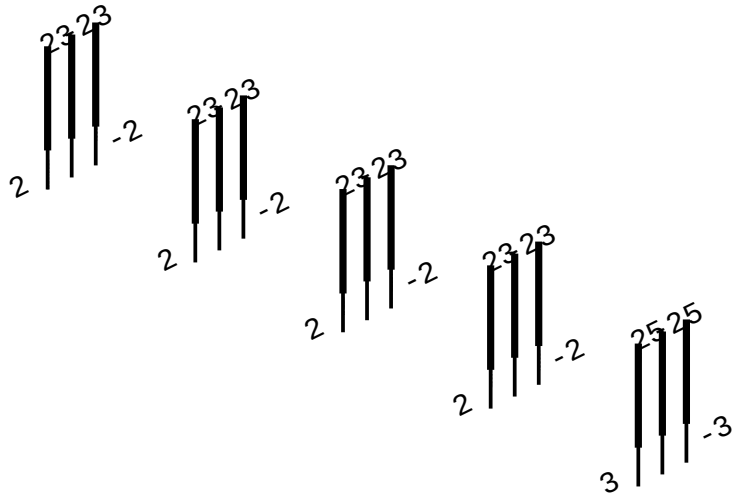
Group: Sipovi
Beam Results: max M2= 425 / min M2= -425 kNm

Load 1: Sopstvena tezina (g)



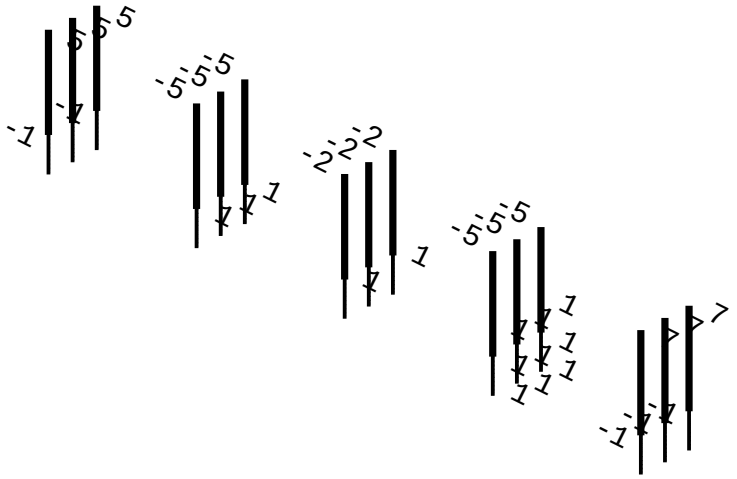
Group: Sipovi
Beam Results: max M1= 18 / min M1= -18 kNm

Load 1: Sopstvena tezina (g)



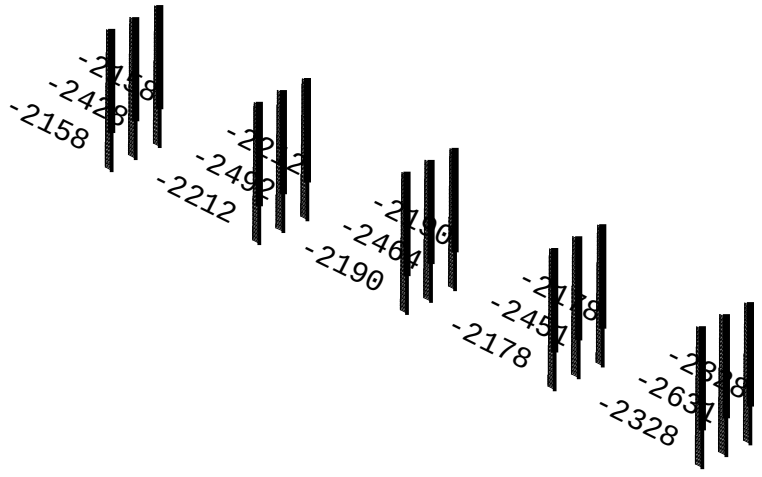
Group: Sipovi
Beam Results: max V3= 88 / min V3= -88 kN

Load 1: Sopstvena tezina (g)



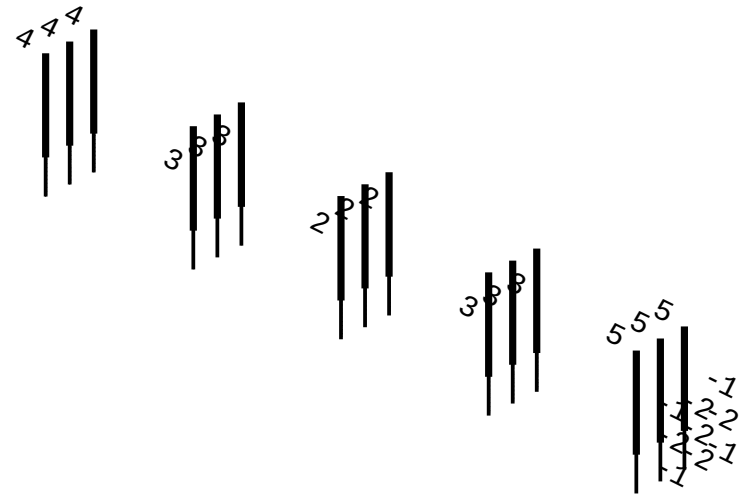
Group: Sipovi
Beam Results: max V2= 2159 / min V2= -2431 kN

Load 1: Sopstvena tezina (g)



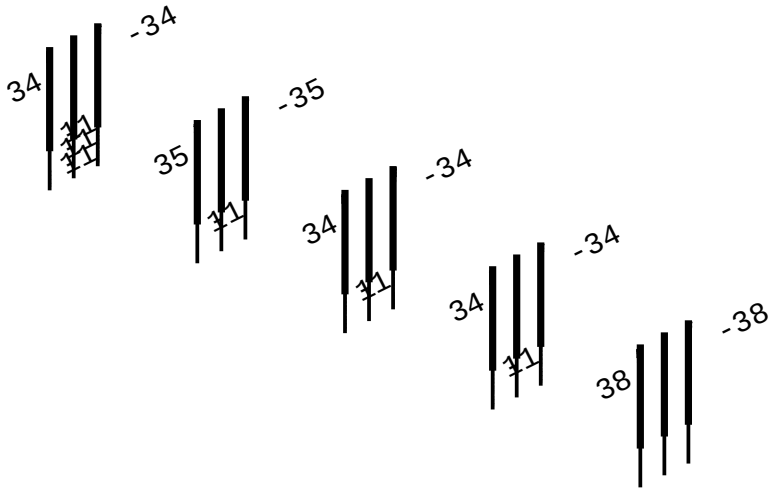
Group: Sipovi
Beam Results: max N1= 65 / min N1= -2631 kN

Load 2: Dodato stalno



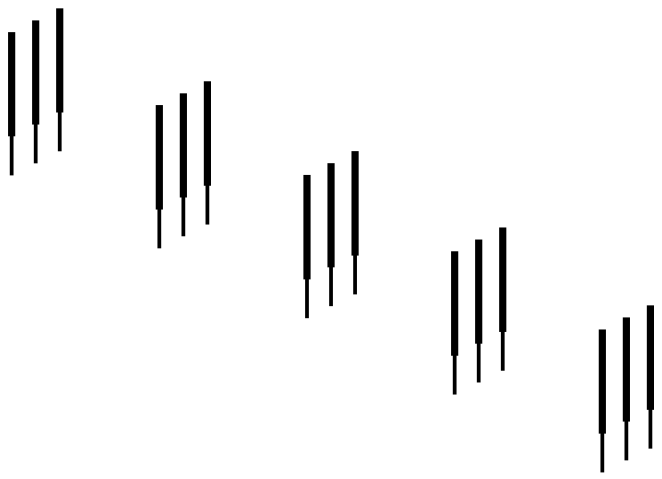
Group: Sipovi
Beam Results: max M3= 1549 / min M3= -2148 kNm

Load 2: Dodato stalno



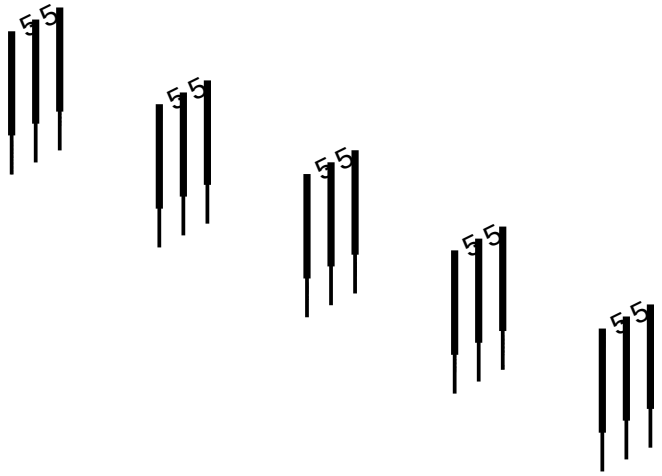
Group: Sipovi
Beam Results: max M2= 87 / min M2= -87 kNm

Load 2: Dodato stalno



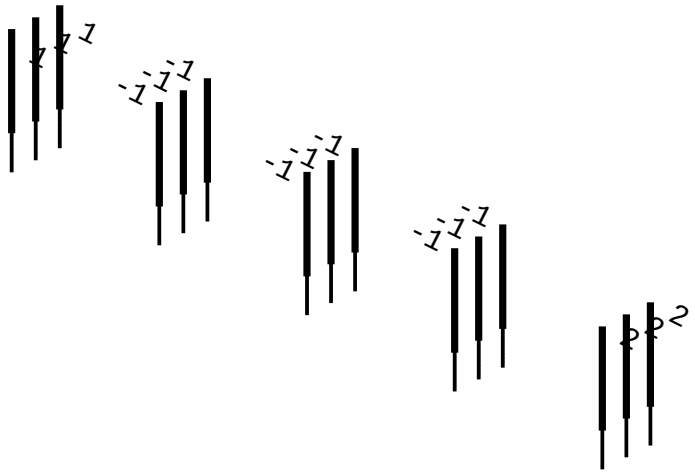
Group: Sipovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 2: Dodato stalno



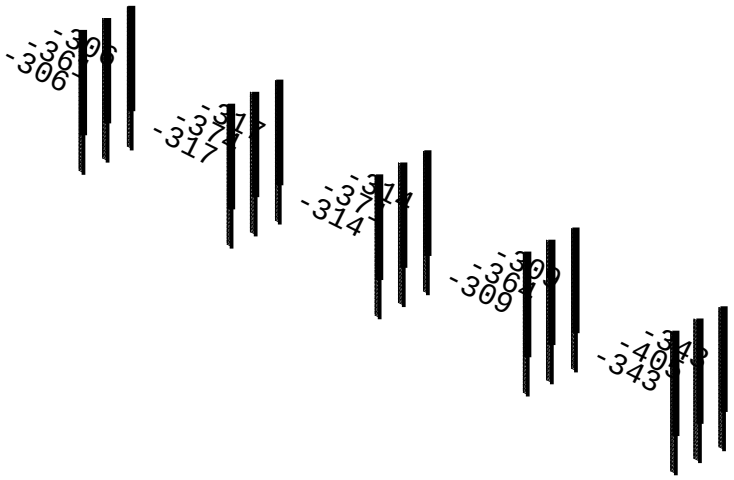
Group: Sipovi
Beam Results: max V3= 18 / min V3= -18 kN

Load 2: Dodato stalno



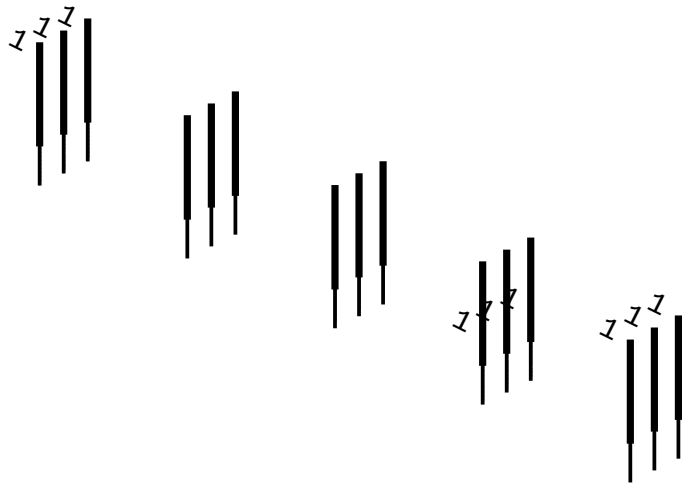
Group: Sipovi
Beam Results: max V2= 513 / min V2= -578 kN

Load 2: Dodato stalno



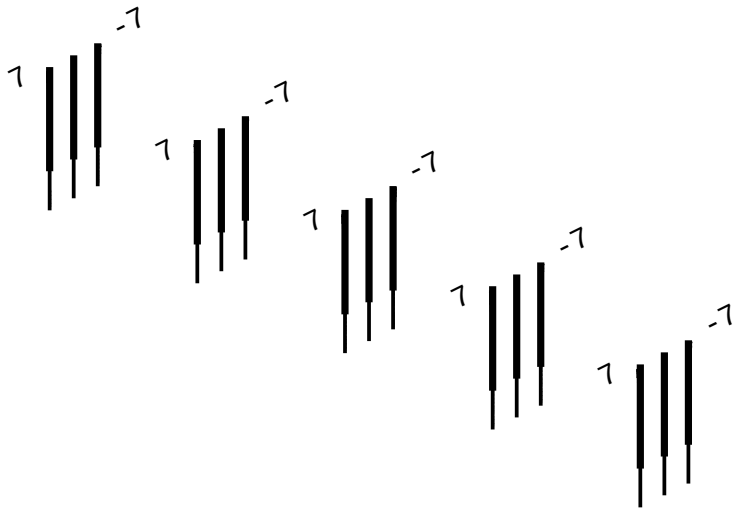
Group: Sipovi
Beam Results: max N1= 13 / min N1= -546 kN

Load 3: UDL (20%)



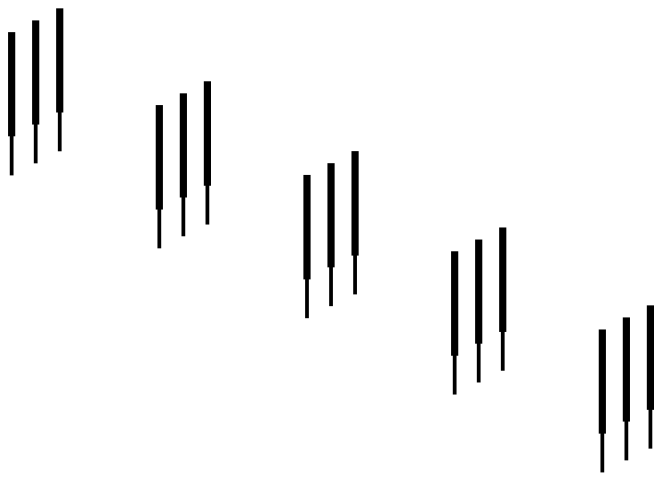
Group: Sipovi
Beam Results: max M3= 302 / min M3= -418 kNm

Load 3: UDL (20%)



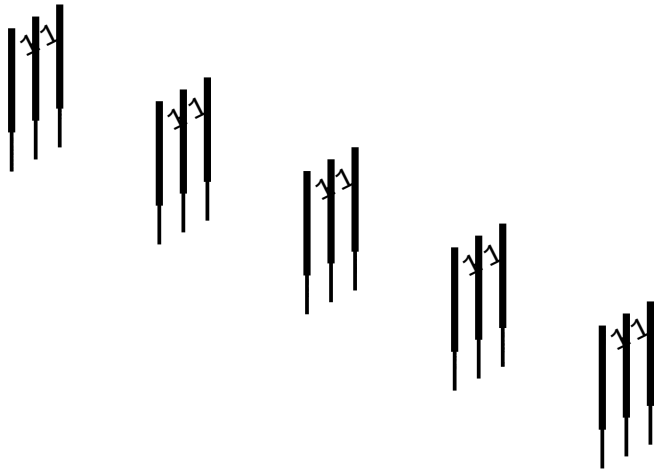
Group: Sipovi
Beam Results: max M2= 17 / min M2= -17 kNm

Load 3: UDL (20%)



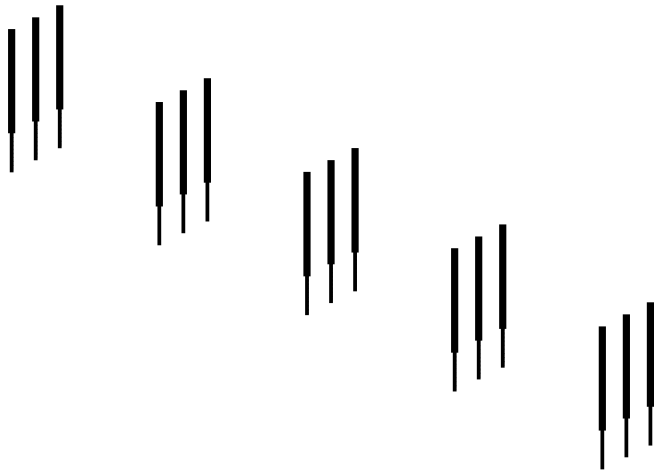
Group: Sipovi
Beam Results: max M1= 1 / min M1= -1 kNm

Load 3: UDL (20%)



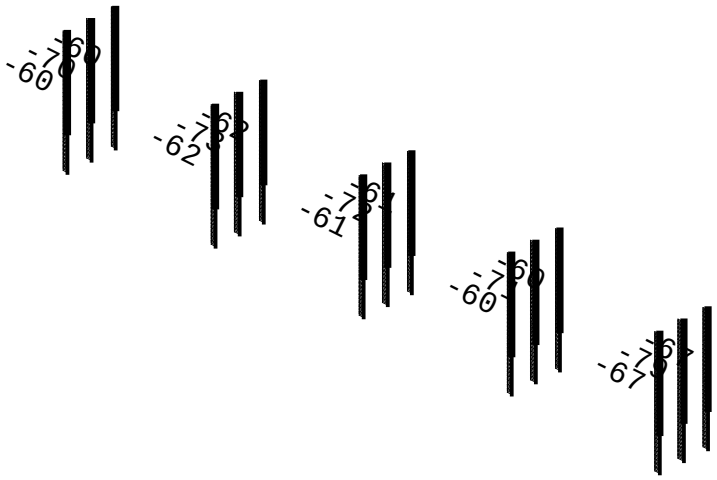
Group: Sipovi
Beam Results: max V3= 4 / min V3= -4 kN

Load 3: UDL (20%)



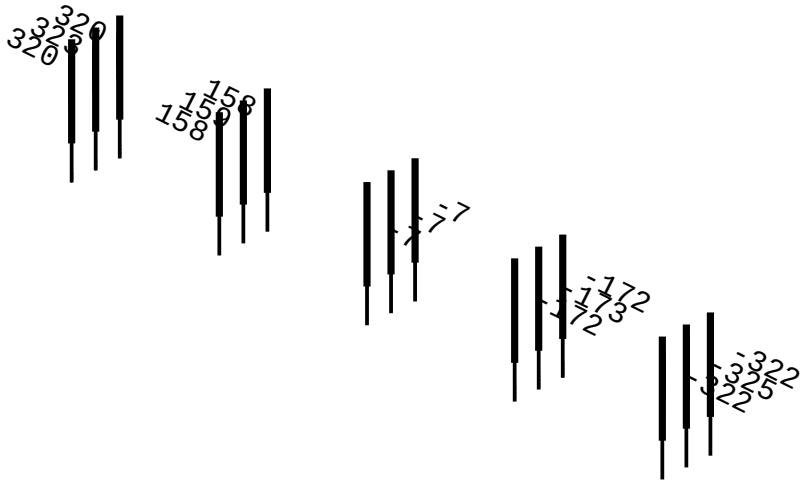
Group: Sipovi
Beam Results: max V2= 100 / min V2= -113 kN

Load 3: UDL (20%)



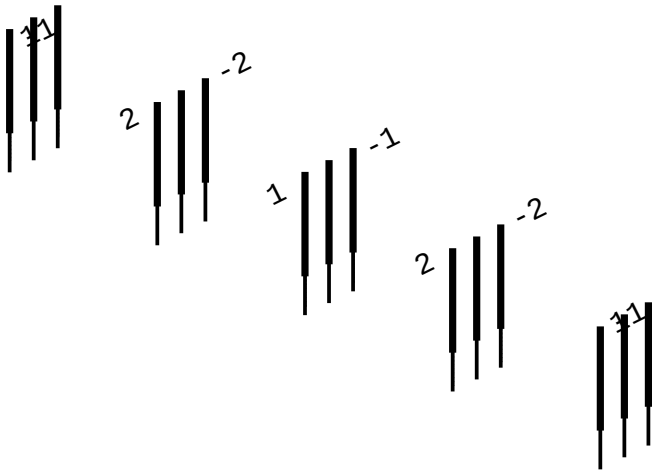
Group: Sipovi
Beam Results: max N1= 3 / min N1= -106 kN

Load 4: Skupljanje



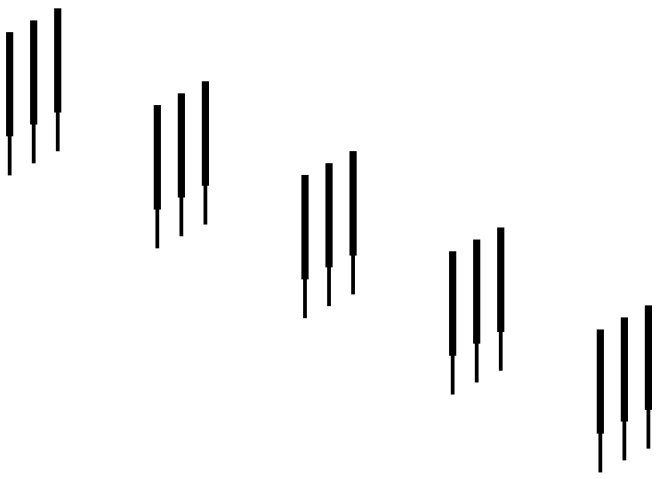
Group: Sipovi
Beam Results: max M3= 870 / min M3= -761 kNm

Load 4: Skupljanje



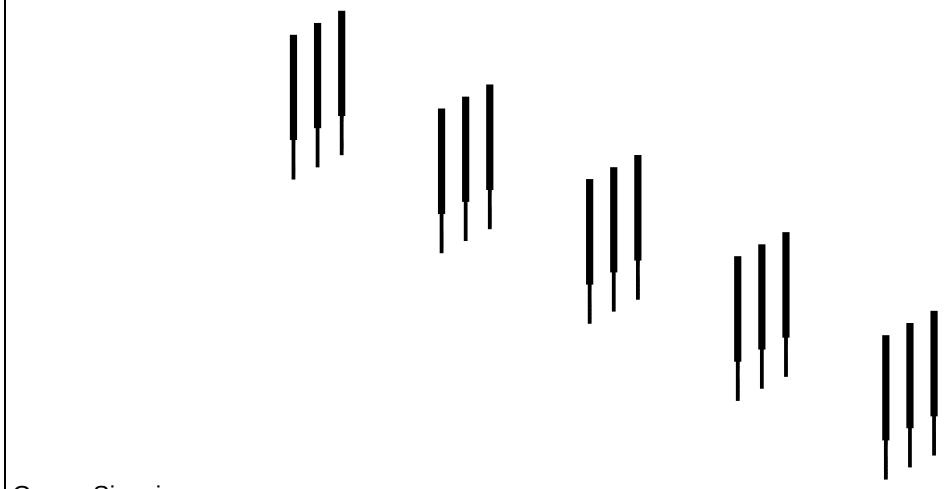
Group: Sipovi
Beam Results: max M2= 172 / min M2= -161 kNm

Load 4: Skupljanje



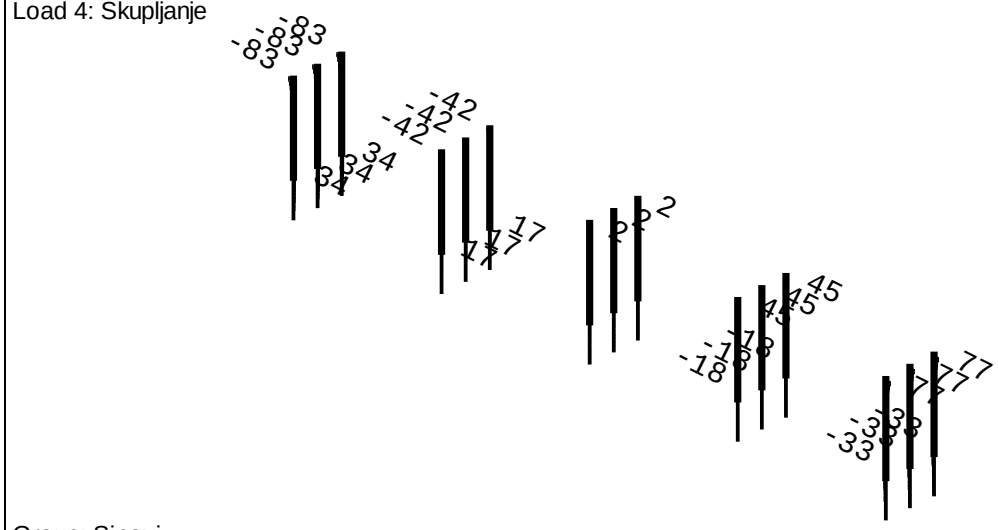
Group: Sipovi
Beam Results: max M1= 176 / min M1= -176 kNm

Load 4: Skupljanje



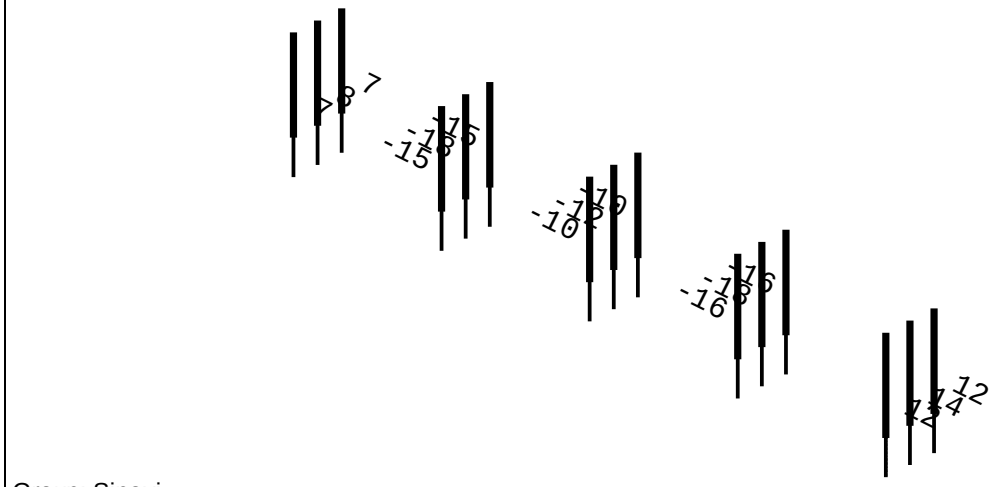
Group: Sipovi
Beam Results: max V3= 91 / min V3= -91 kN

Load 4: Skupljanje



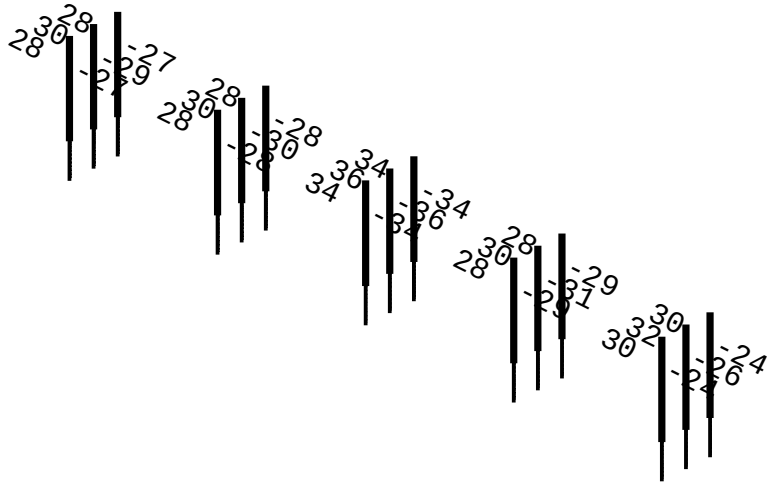
Group: Sipovi
Beam Results: max V2= 127 / min V2= -136 kN

Load 4: Skupljanje



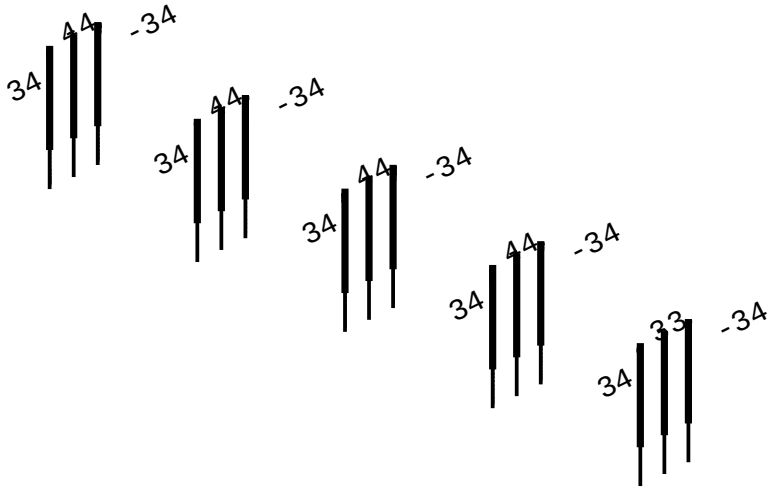
Group: Sipovi
Beam Results: max N1= 409 / min N1= -25 kN

Load 5: TS



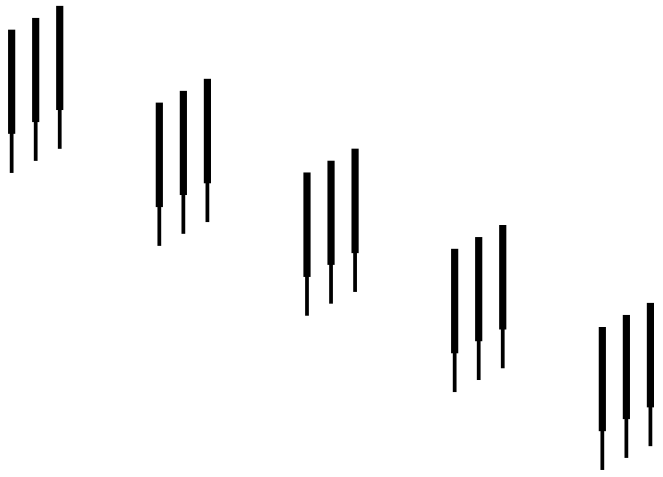
Group: Sipovi
Beam Results: max M3= 3997 / min M3= -2252 kNm

Load 5: TS



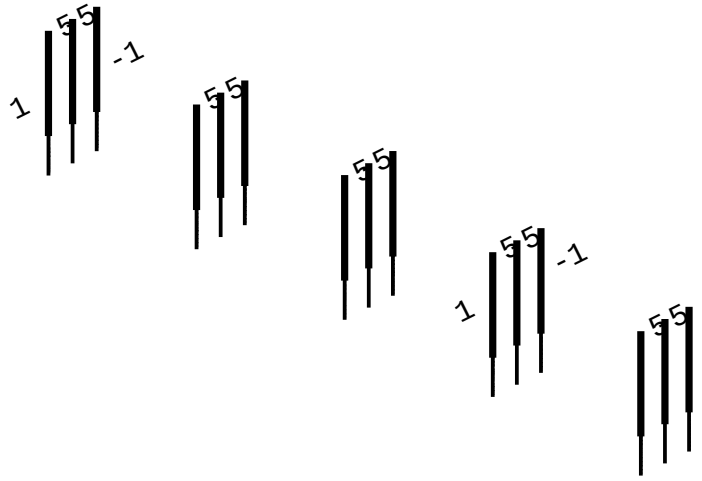
Group: Sipovi
Beam Results: max M2= 85 / min M2= -85 kNm

Load 5: TS



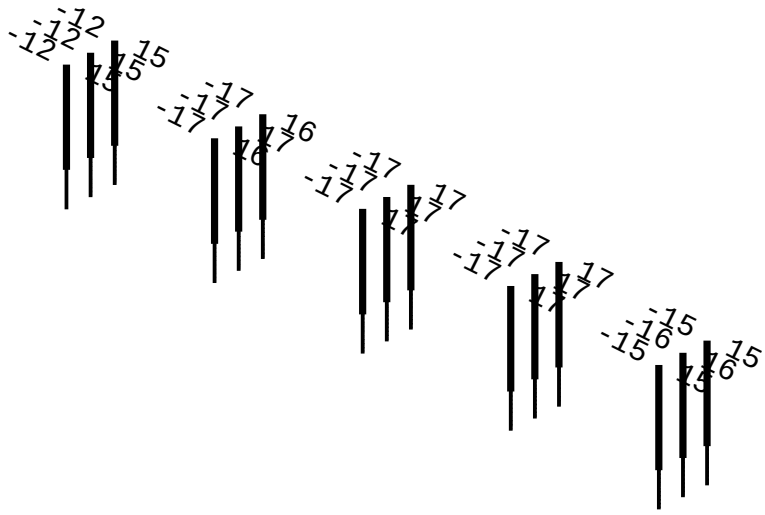
Group: Sipovi
Beam Results: max M1= 34 / min M1= -34 kNm

Load 5: TS



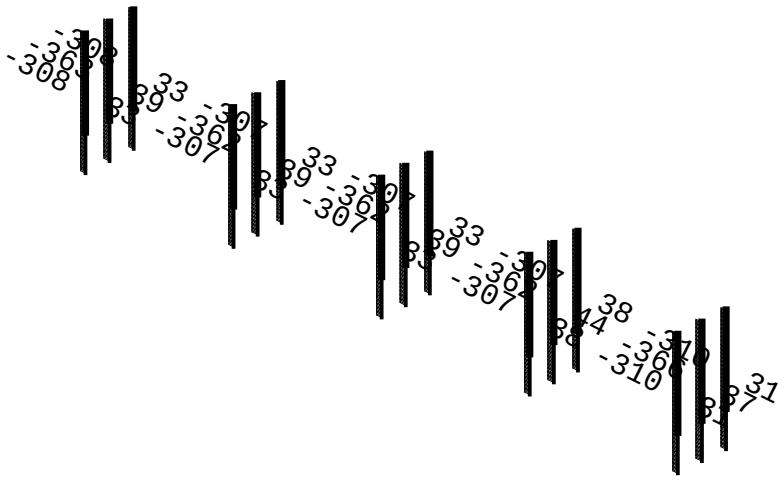
Group: Sipovi
Beam Results: max V3= 18 / min V3= -18 kN

Load 5: TS



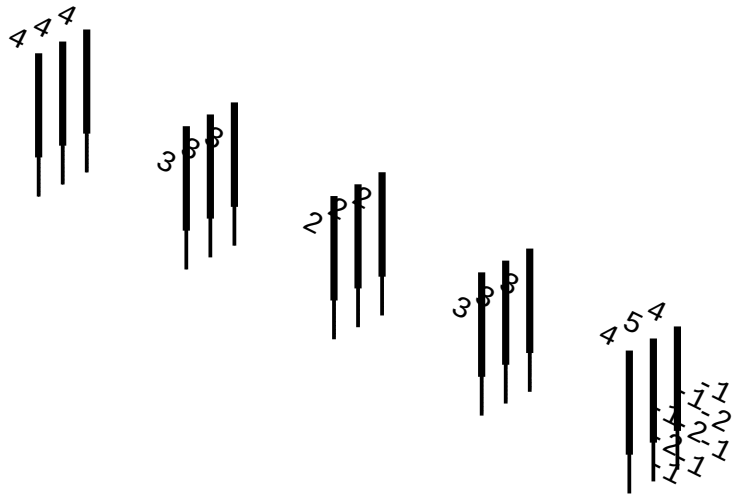
Group: Sipovi
Beam Results: max V2= 969 / min V2= -969 kN

Load 5: TS



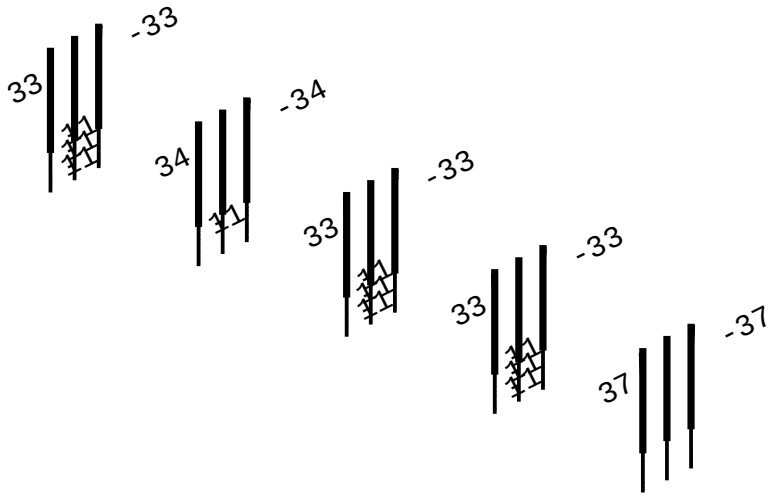
Group: Sipovi
Beam Results: max N1= 60 / min N1= -493 kN

Load 6: UDL



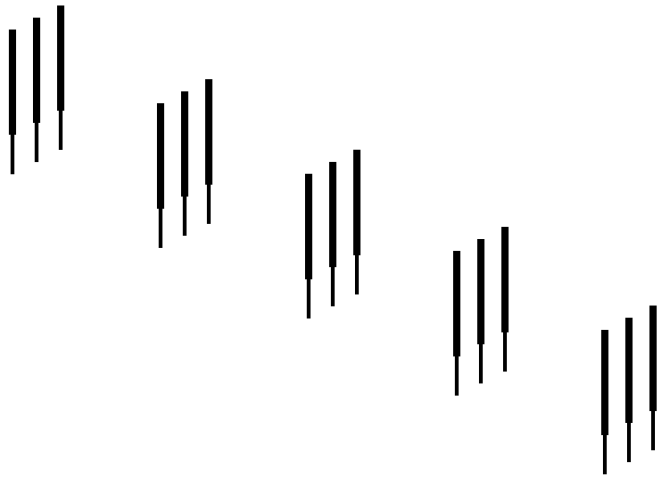
Group: Sipovi
Beam Results: max M3= 1510 / min M3= -2092 kNm

Load 6: UDL



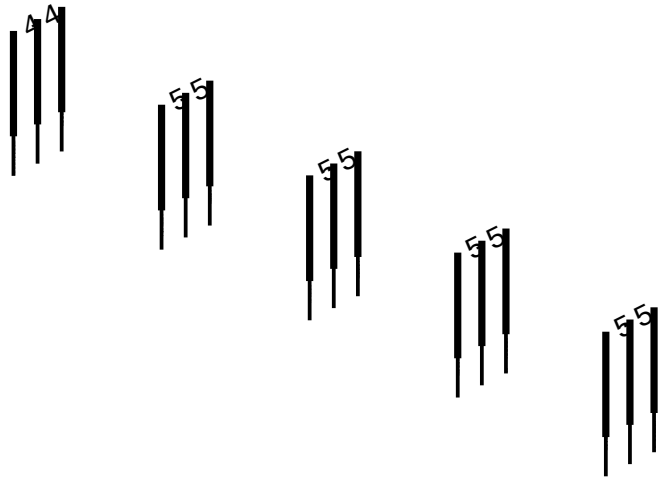
Group: Sipovi
Beam Results: max M2= 85 / min M2= -85 kNm

Load 6: UDL



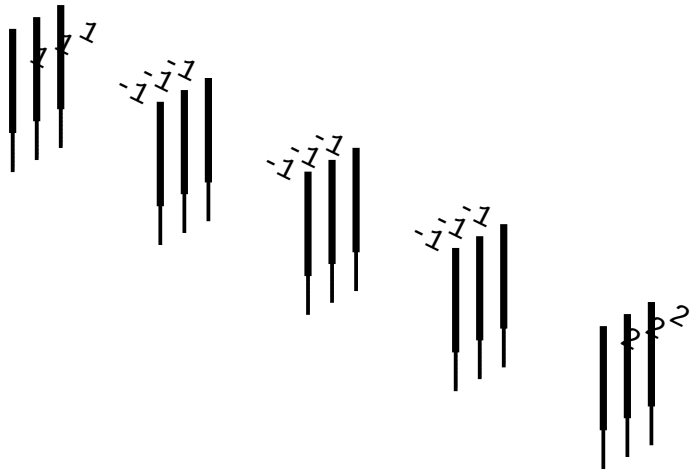
Group: Sipovi
Beam Results: max M1= 4 / min M1= -4 kNm

Load 6: UDL



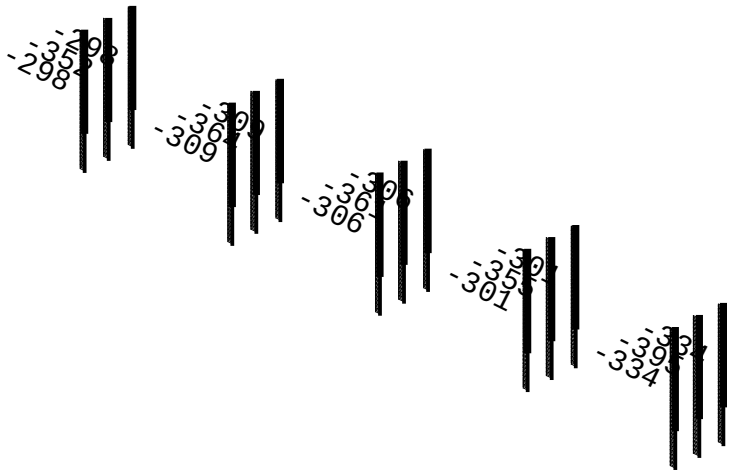
Group: Sipovi
Beam Results: max V3= 18 / min V3= -18 kN

Load 6: UDL



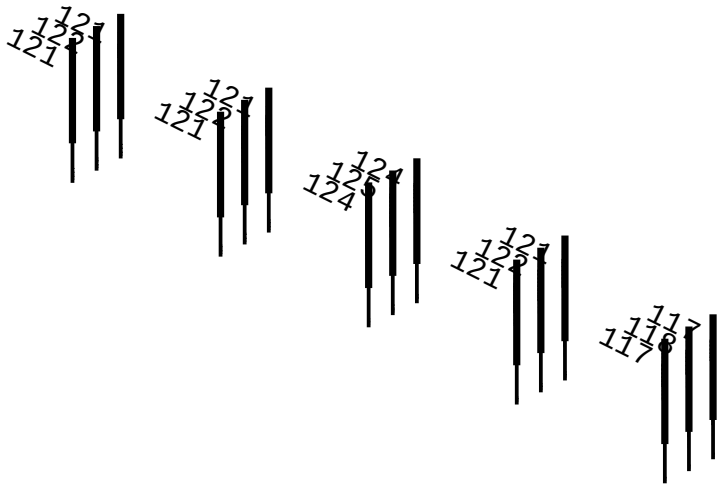
Group: Sipovi
Beam Results: max V2= 500 / min V2= -563 kN

Load 6: UDL



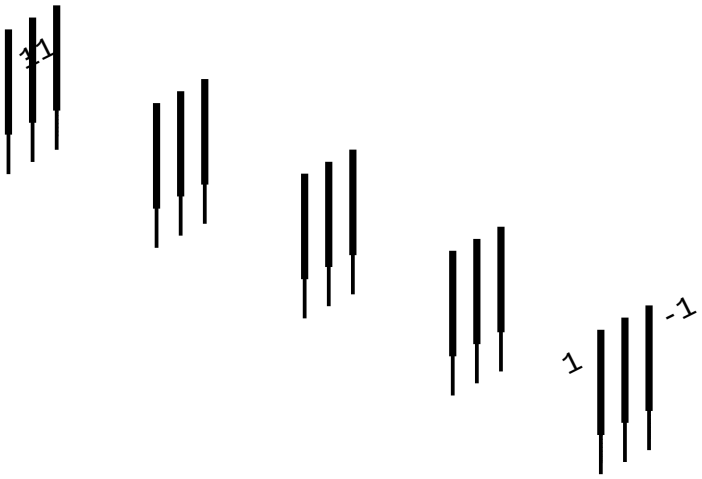
Group: Sipovi
Beam Results: max N1= 13 / min N1= -532 kN

Load 7: Kocenje



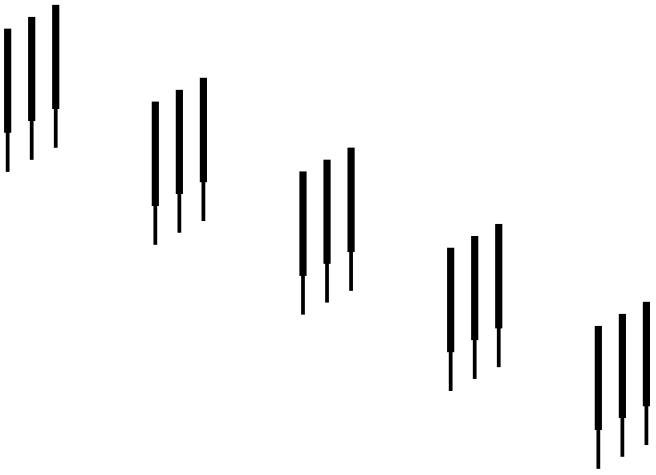
Group: Sipovi
Beam Results: max M3= 337 / min M3= -341 kNm

Load 7: Kocenje



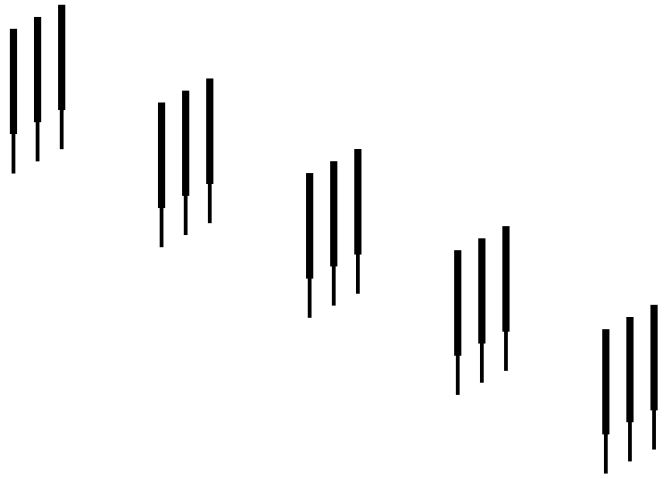
Group: Sipovi
Beam Results: max M2= 71 / min M2= -2 kNm

Load 7: Kocenje



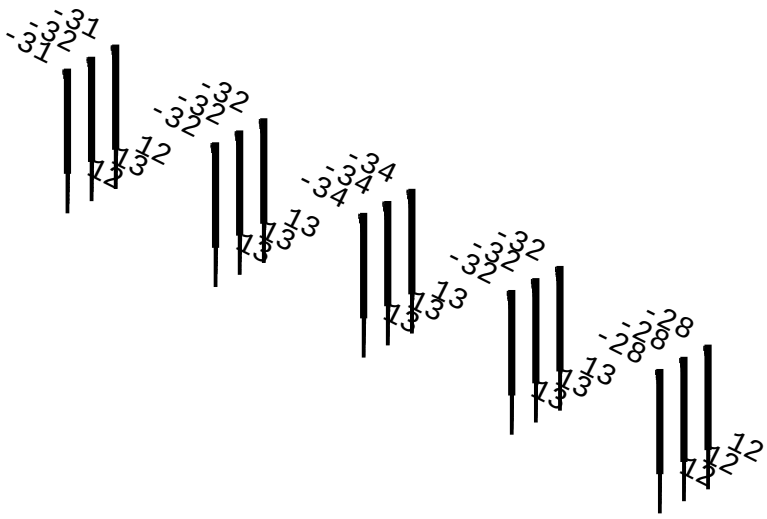
Group: Sipovi
Beam Results: max M1= 64 / min M1= -64 kNm

Load 7: Kocenje



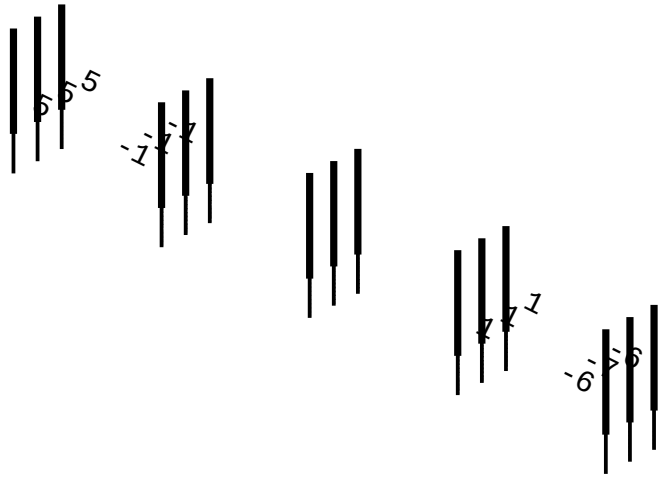
Group: Sipovi
Beam Results: max V3= 37 / min V3= -37 kN

Load 7: Kocenje



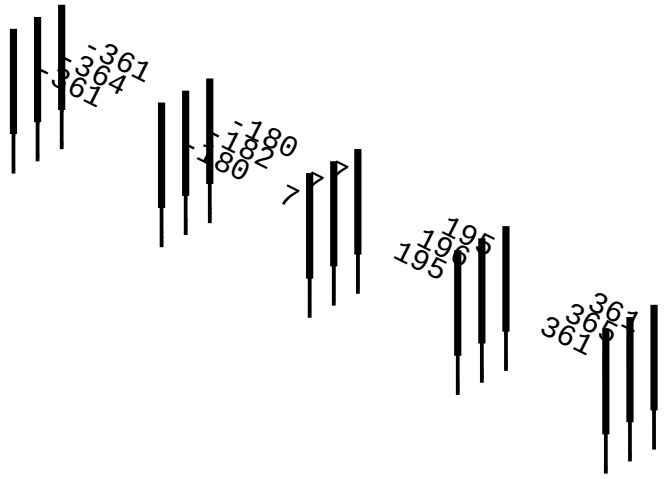
Group: Sipovi
Beam Results: max V2= 29 / min V2= -56 kN

Load 7: Kocenje



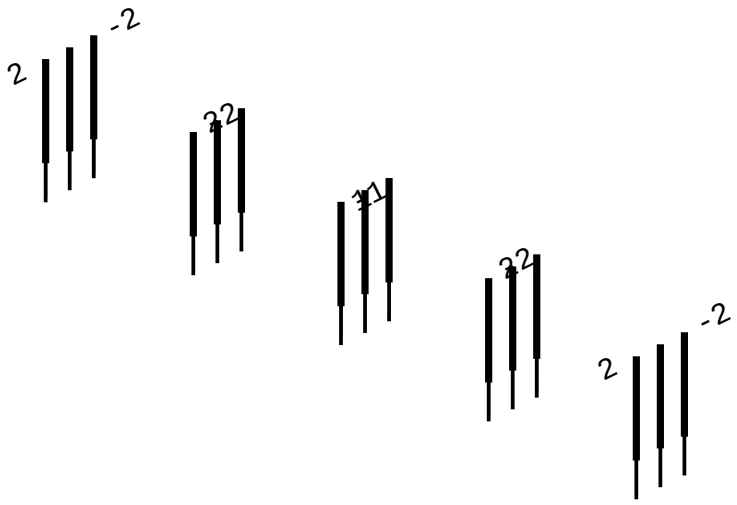
Group: Sipovi
Beam Results: max N1= 86 / min N1= -70 kN

Load 8: to+34



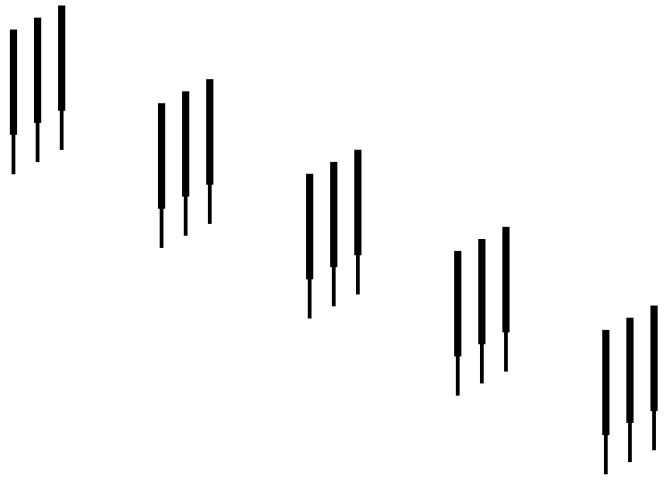
Group: Sipovi
Beam Results: max M3= 824 / min M3= -1212 kNm

Load 8: to+34



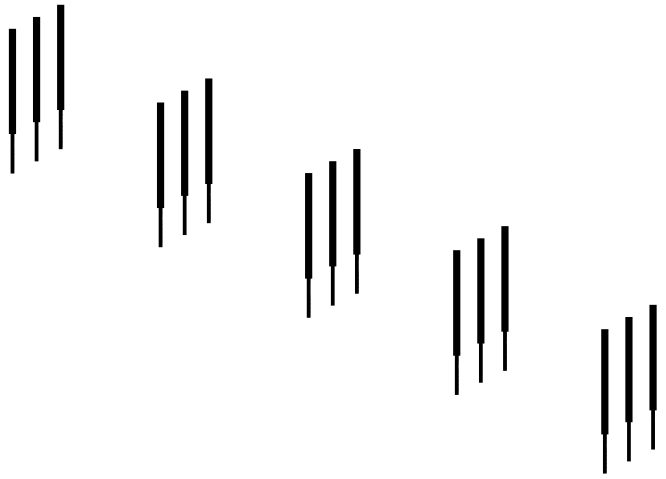
Group: Sipovi
Beam Results: max M2= 178 / min M2= -190 kNm

Load 8: to+34



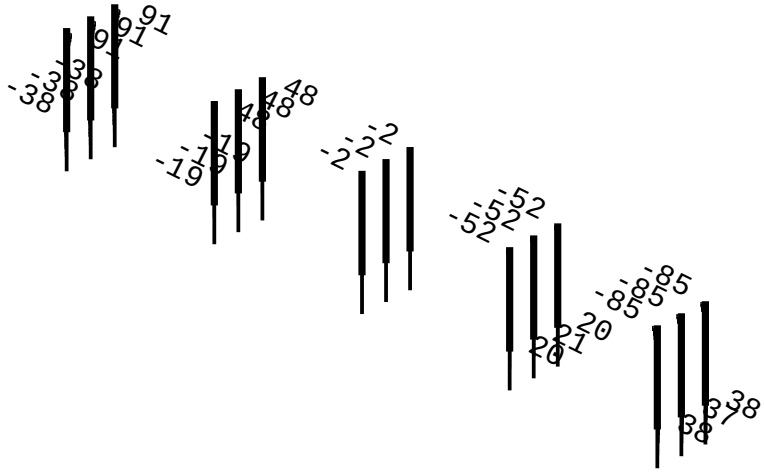
Group: Sipovi
Beam Results: max M1= 202 / min M1= -202 kNm

Load 8: to+34



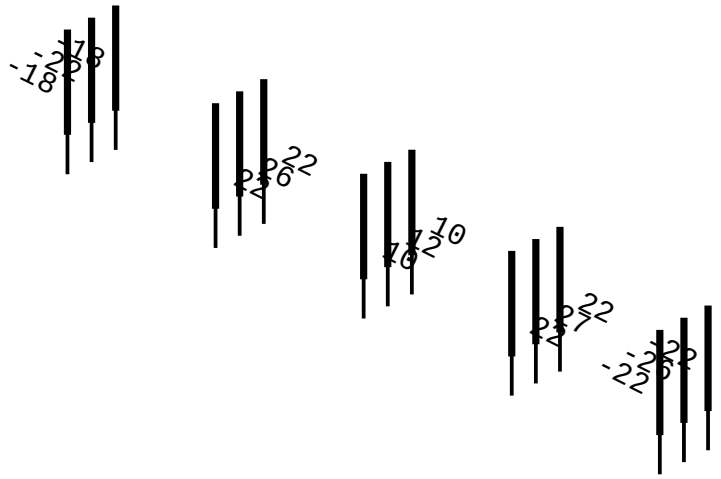
Group: Sipovi
Beam Results: max V3= 100 / min V3= -100 kN

Load 8: to+34



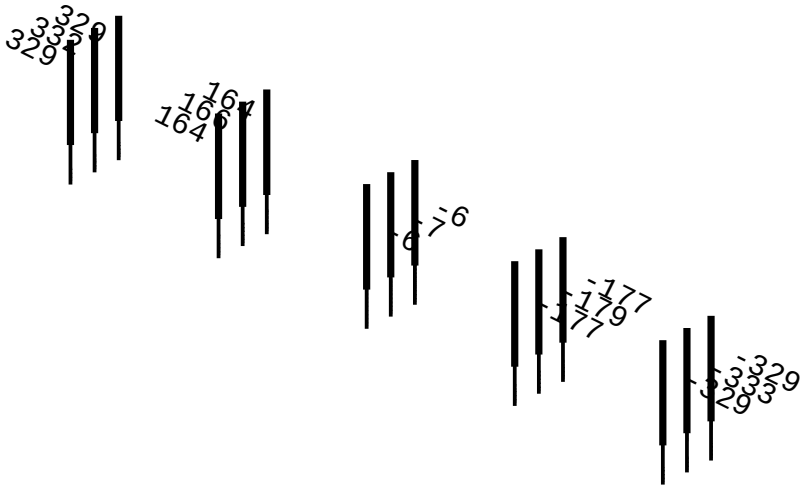
Group: Sipovi
Beam Results: max V2= 150 / min V2= -140 kN

Load 8: to+34



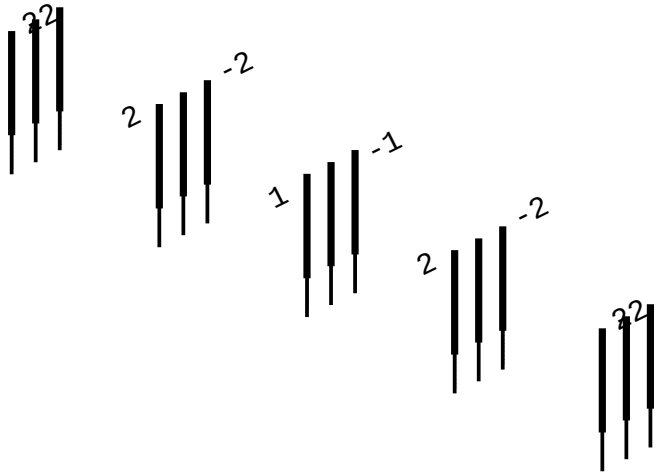
Group: Sipovi
Beam Results: max N1= 36 / min N1= -458 kN

Load 9: to-31



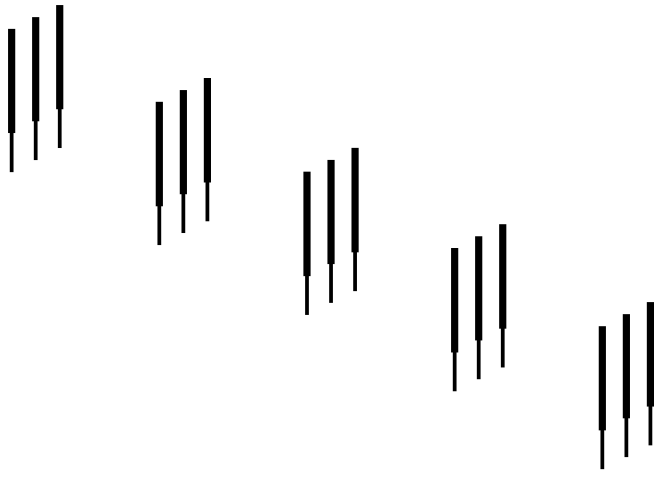
Group: Sipovi
Beam Results: max M3= 1105 / min M3= -751 kNm

Load 9: to-31



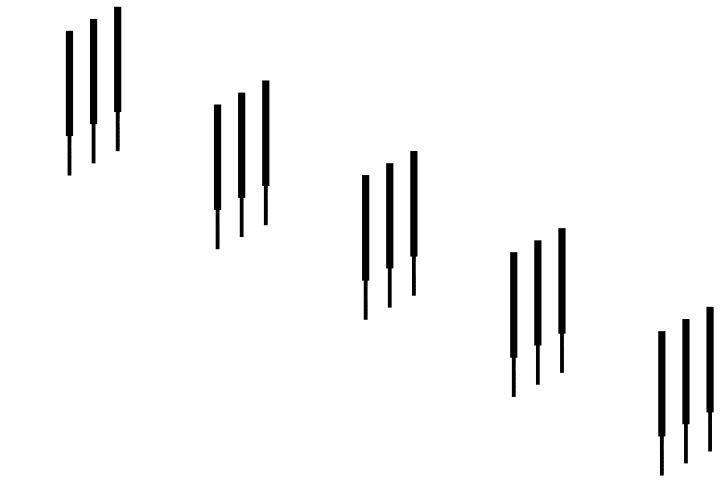
Group: Sipovi
Beam Results: max M2= 173 / min M2= -162 kNm

Load 9: to-31



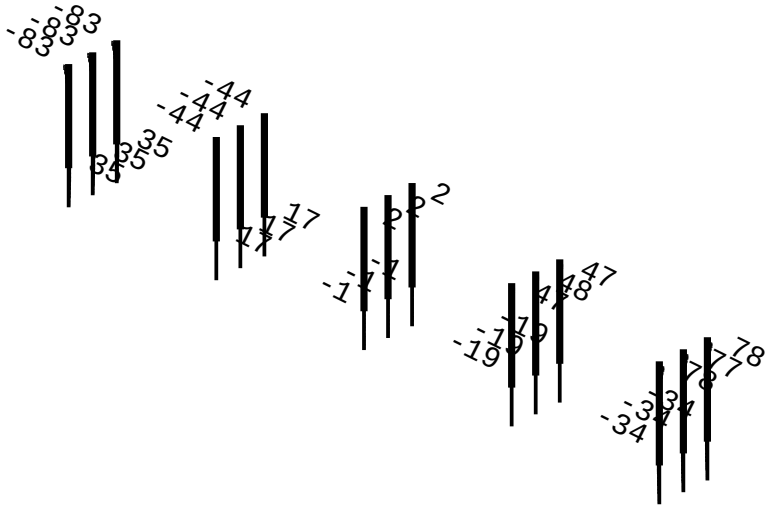
Group: Sipovi
Beam Results: max M1= 184 / min M1= -184 kNm

Load 9: to-31



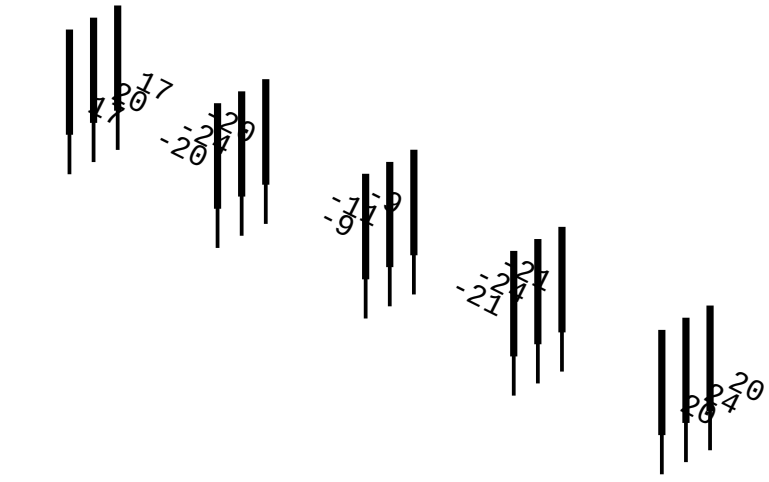
Group: Sipovi
Beam Results: max V3= 91 / min V3= -91 kN

Load 9: to-31



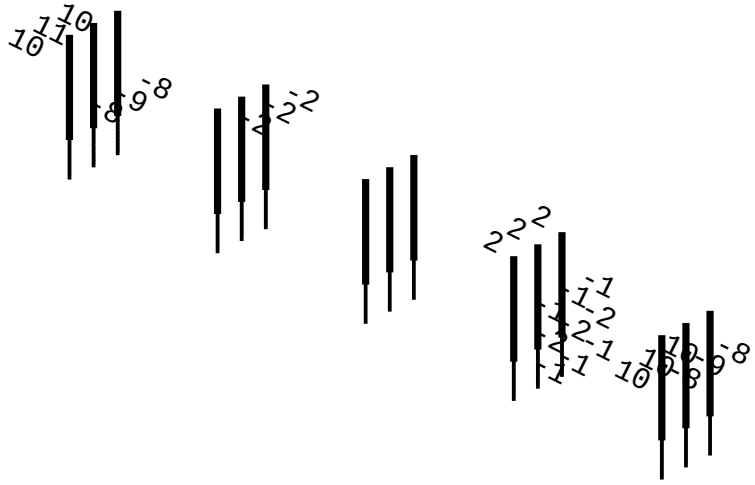
Group: Sipovi
Beam Results: max V2= 128 / min V2= -137 kN

Load 9: to-31



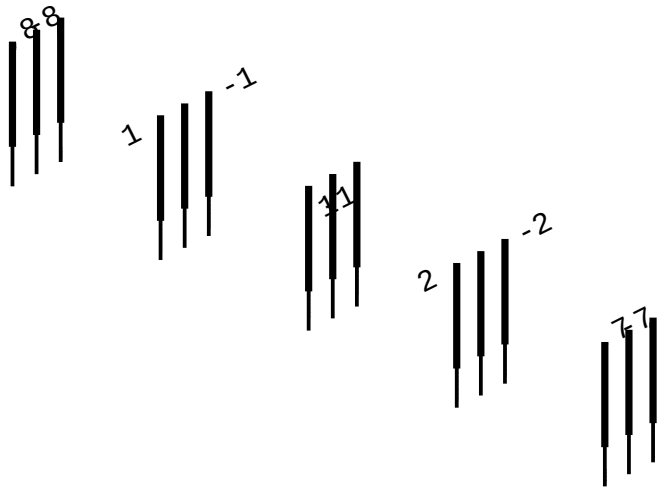
Group: Sipovi
Beam Results: max N1= 418 / min N1= -33 kN

Load 10: dt+12.3



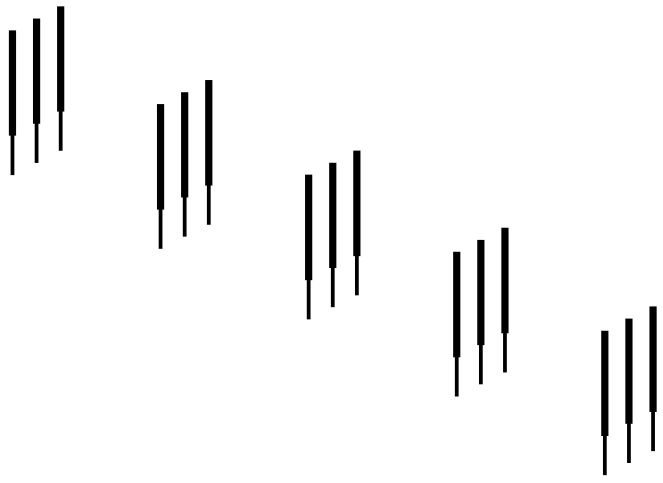
Group: Sipovi
Beam Results: max M3= 3630 / min M3= -134 kNm

Load 10: dt+12.3



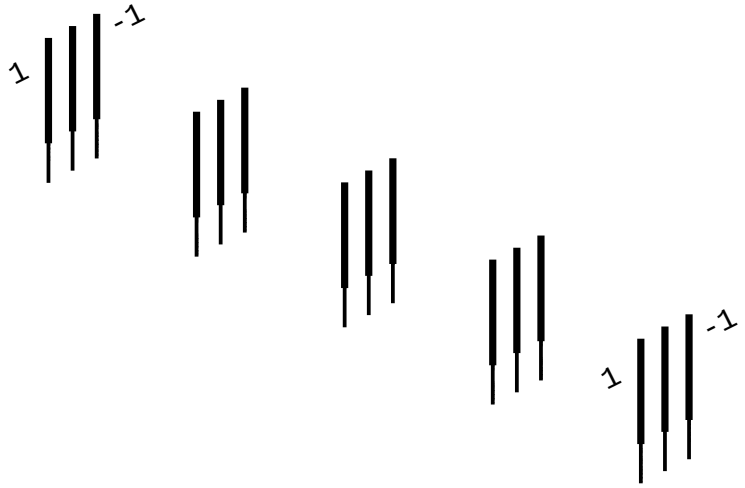
Group: Sipovi
Beam Results: max M2= 20 / min M2= -20 kNm

Load 10: dt+12.3



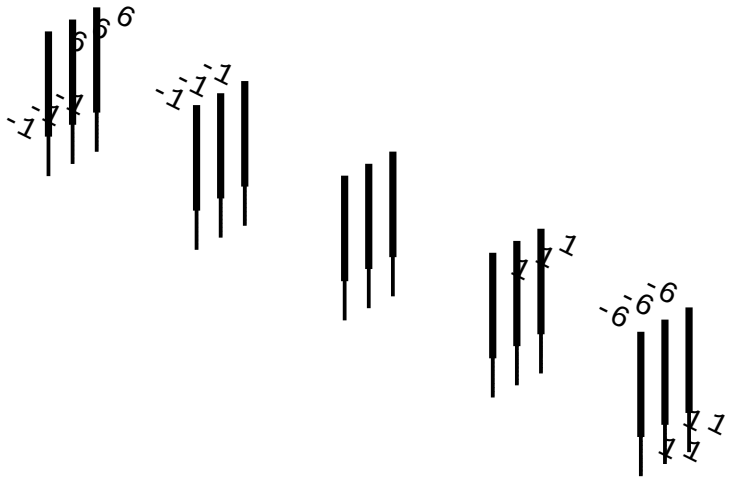
Group: Sipovi
Beam Results: max M1= 10 / min M1= -10 kNm

Load 10: dt+12.3



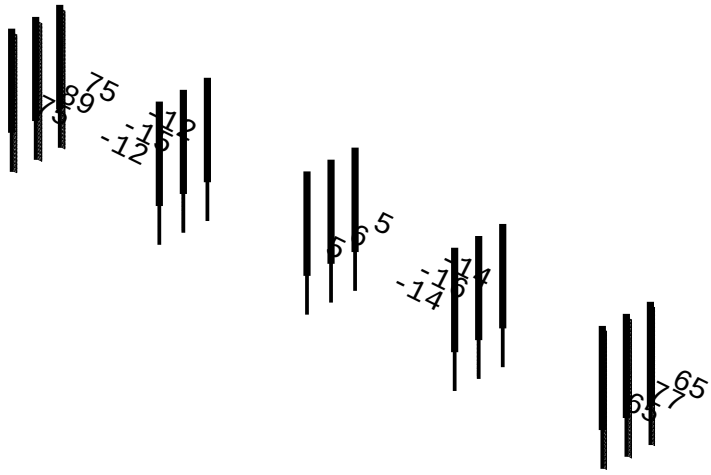
Group: Sipovi
Beam Results: max V3= 7 / min V3= -7 kN

Load 10: dt+12.3



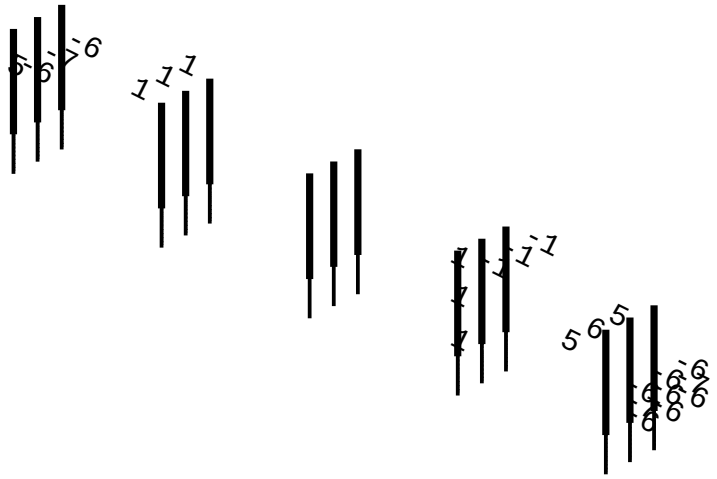
Group: Sipovi
Beam Results: max V2= 172 / min V2= -207 kN

Load 10: dt+12.3



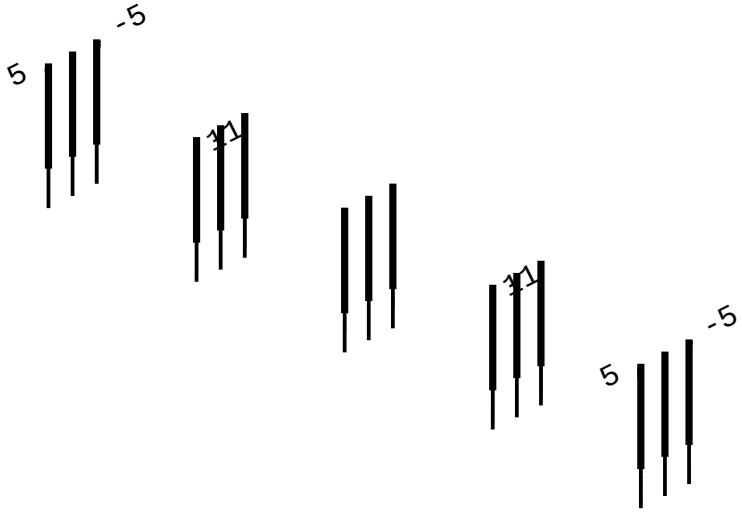
Group: Sipovi
Beam Results: max N1= 119 / min N1= -22 kN

Load 11: dt-8



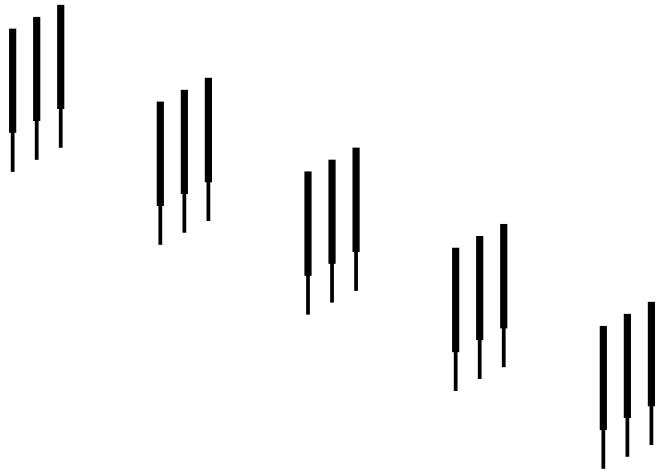
Group: Sipovi
Beam Results: max M3= 87 / min M3= -2361 kNm

Load 11: dt-8



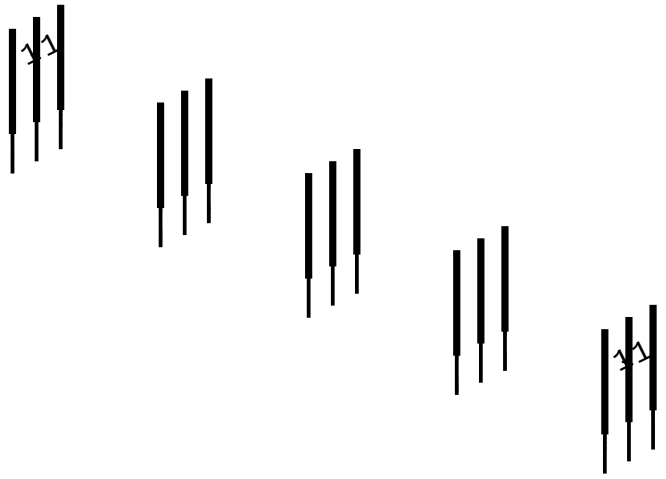
Group: Sipovi
Beam Results: max M2= 13 / min M2= -13 kNm

Load 11: dt-8



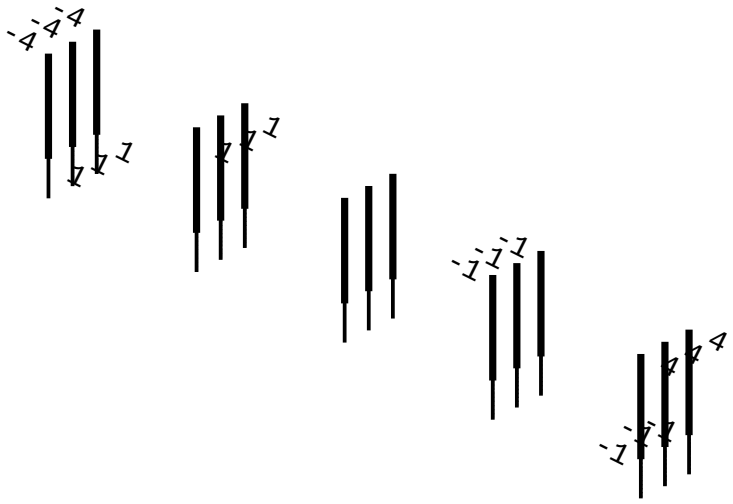
Group: Sipovi
Beam Results: max M1= 6 / min M1= -6 kNm

Load 11: dt-8



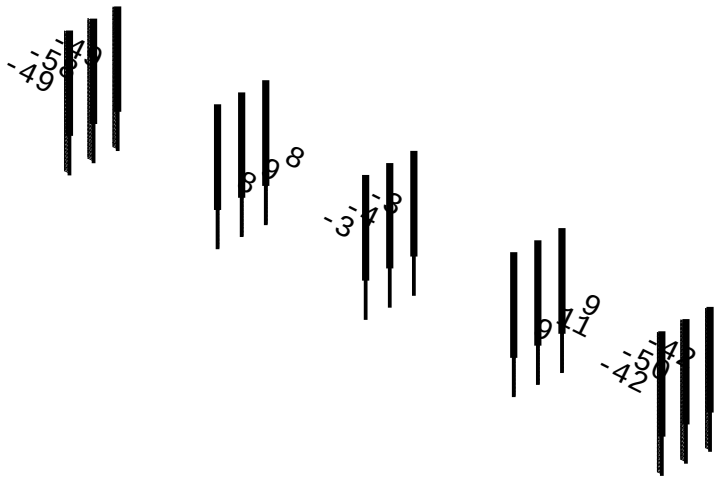
Group: Sipovi
Beam Results: max V3= 4 / min V3= -4 kN

Load 11: dt-8



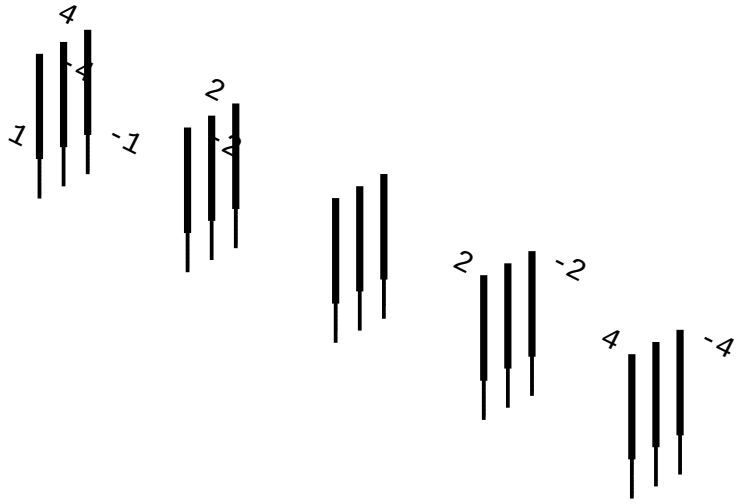
Group: Sipovi
Beam Results: max V2= 135 / min V2= -112 kN

Load 11: dt-8



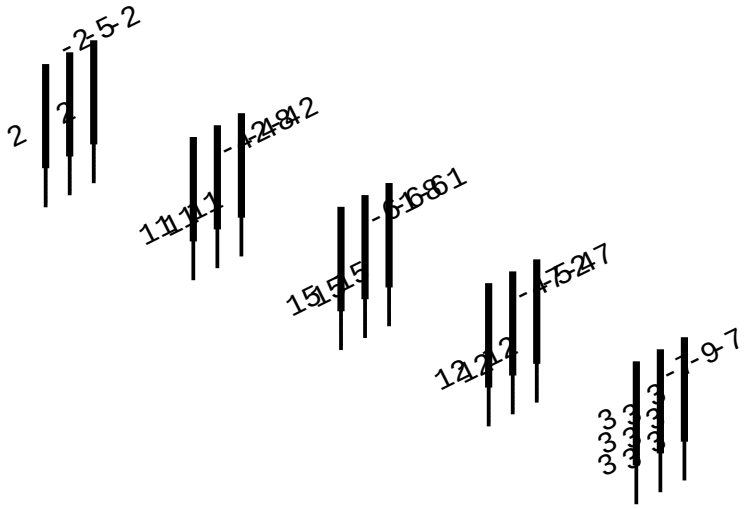
Group: Sipovi
Beam Results: max N1= 14 / min N1= -78 kN

Load 12: Vetar



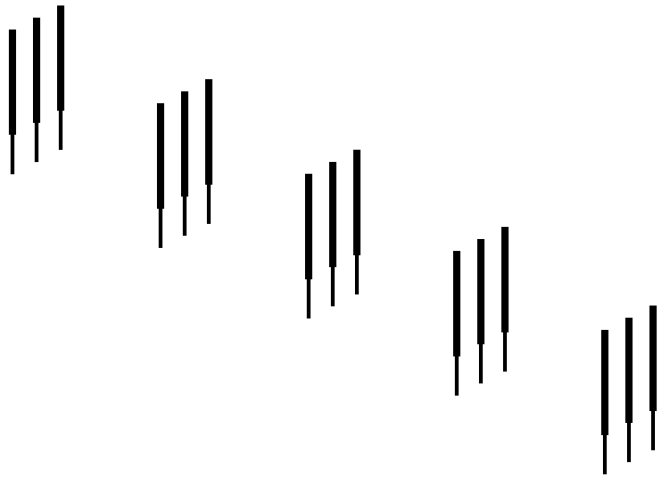
Group: Sipovi
Beam Results: max M3= 230 / min M3= -230 kNm

Load 12: Vetar



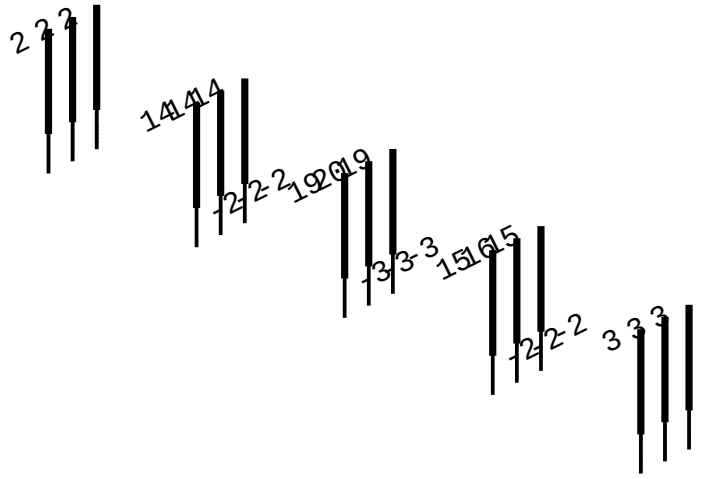
Group: Sipovi
Beam Results: max M2= 243 / min M2= -980 kNm

Load 12: Vetar



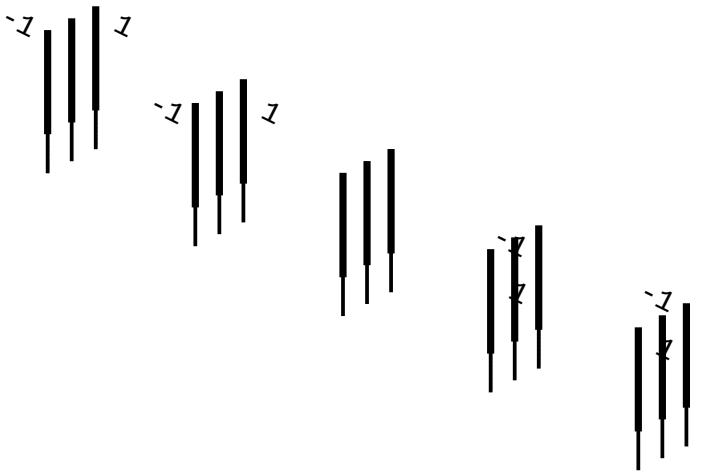
Group: Sipovi
Beam Results: max M1= 98 / min M1= -151 kNm

Load 12: Vetar



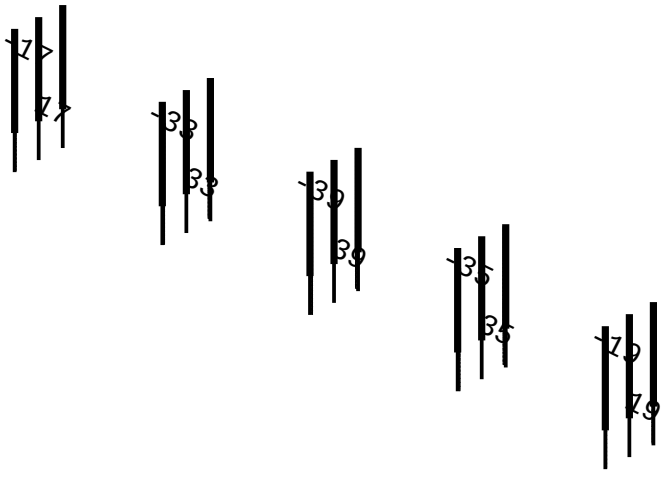
Group: Sipovi
Beam Results: max V3= 65 / min V3= -64 kN

Load 12: Vetar



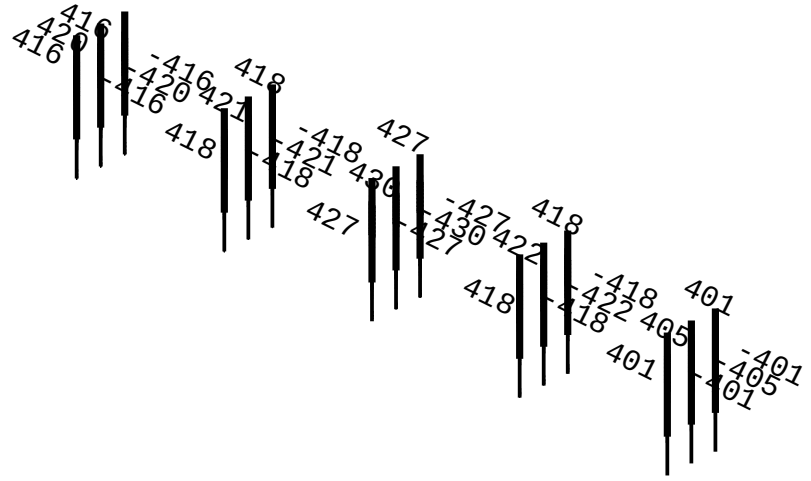
Group: Sipovi
Beam Results: max V2= 155 / min V2= -1 kN

Load 12: Vetar



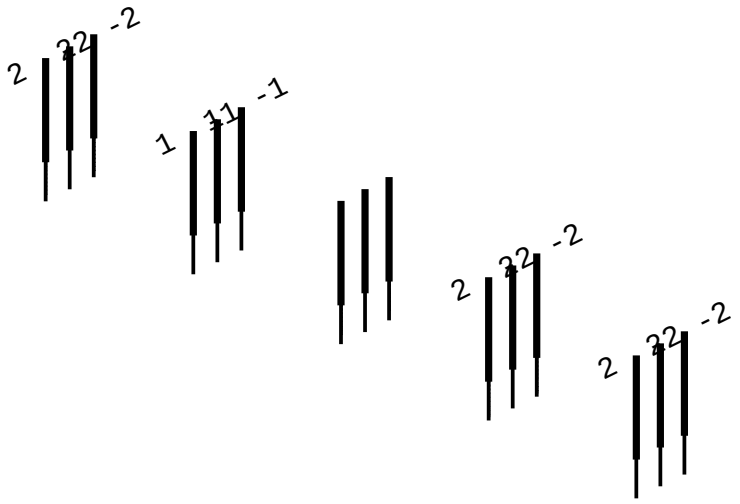
Group: Sipovi
Beam Results: max N1= 116 / min N1= -116 kN

Load 13: Sx



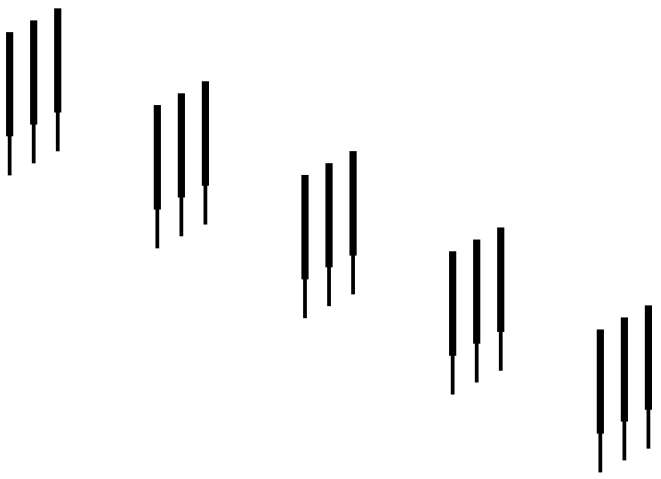
Group: Sipovi
Beam Results: max M3= 1155 / min M3= -1155 kNm

Load 13: Sx



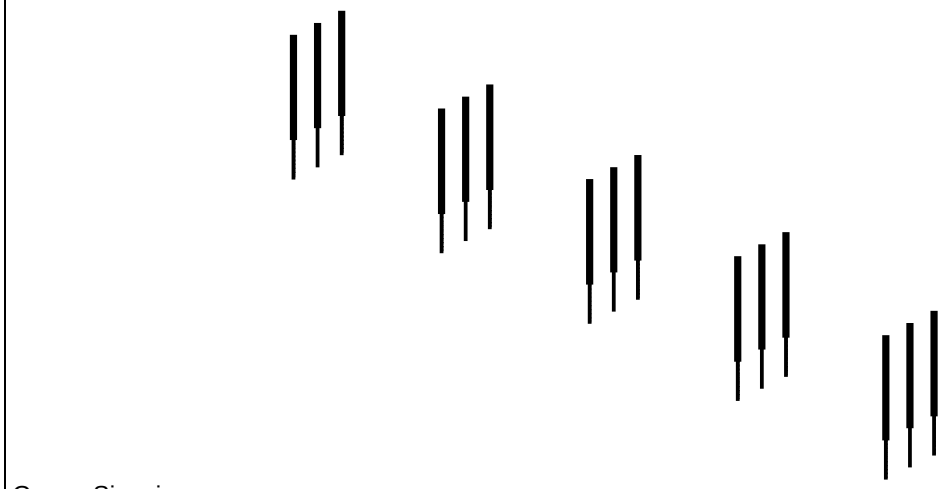
Group: Sipovi
Beam Results: max M2= 244 / min M2= -244 kNm

Load 13: Sx



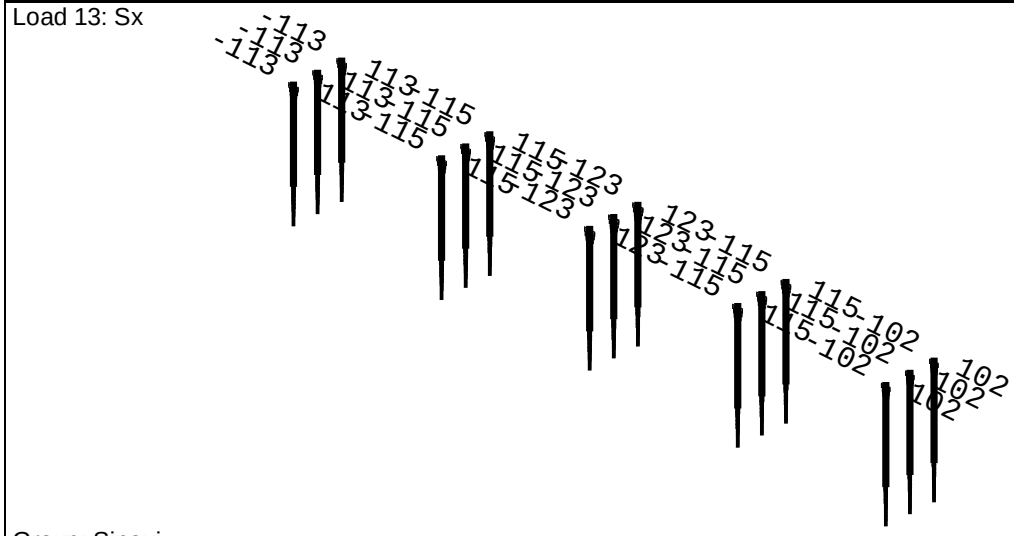
Group: Sipovi
Beam Results: max M1= 208 / min M1= -208 kNm

Load 13: Sx



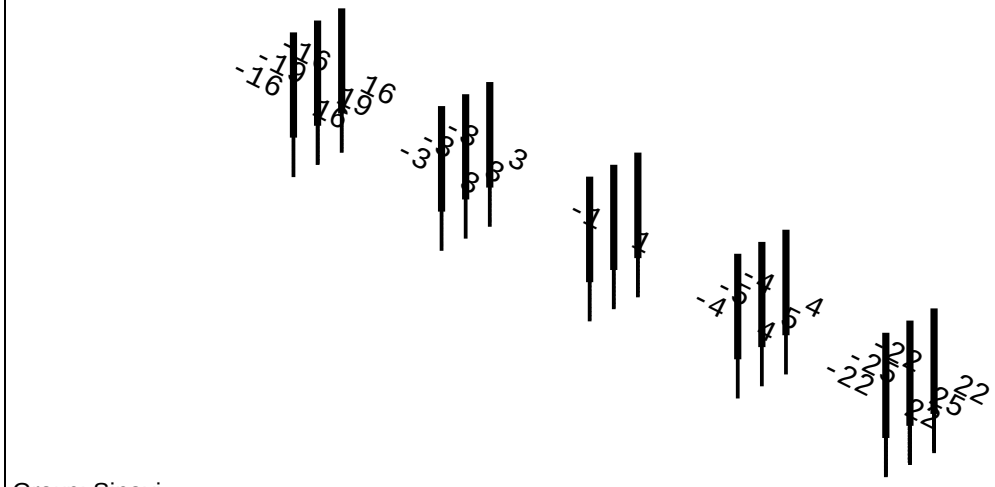
Group: Sipovi
Beam Results: max V3= 129 / min V3= -129 kN

Load 13: Sx



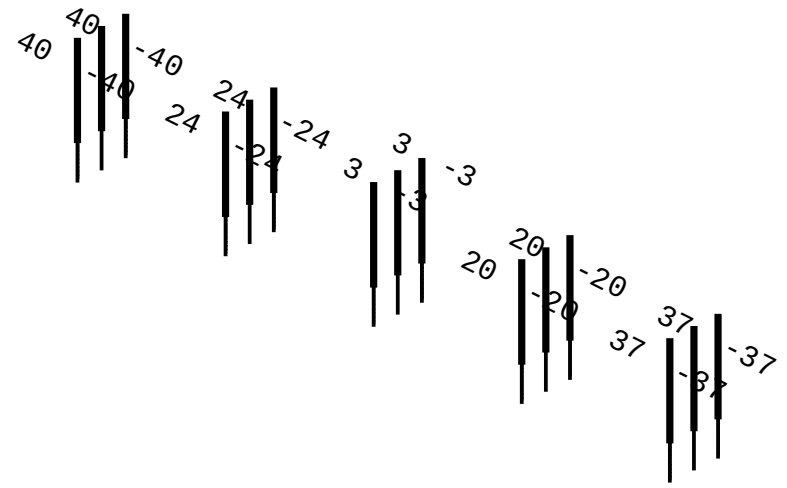
Group: Sipovi
Beam Results: max V2= 188 / min V2= -188 kN

Load 13: Sx



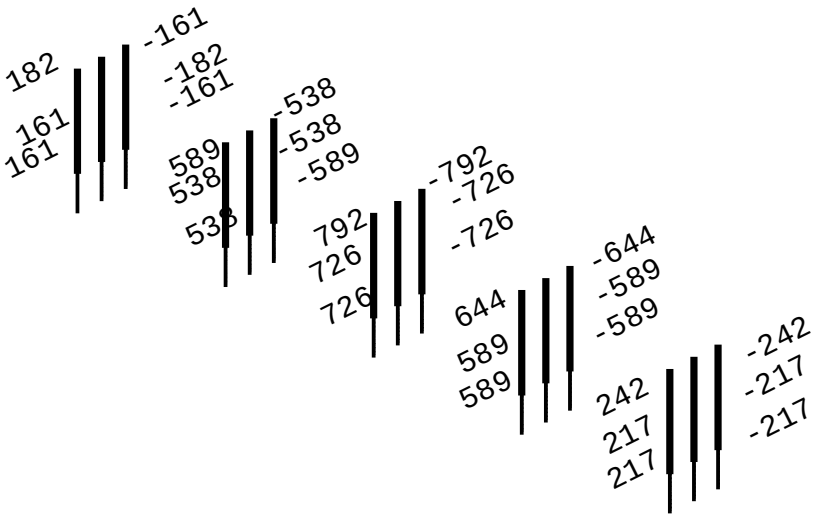
Group: Sipovi
Beam Results: max N1= 140 / min N1= -140 kN

Load 14: Sy



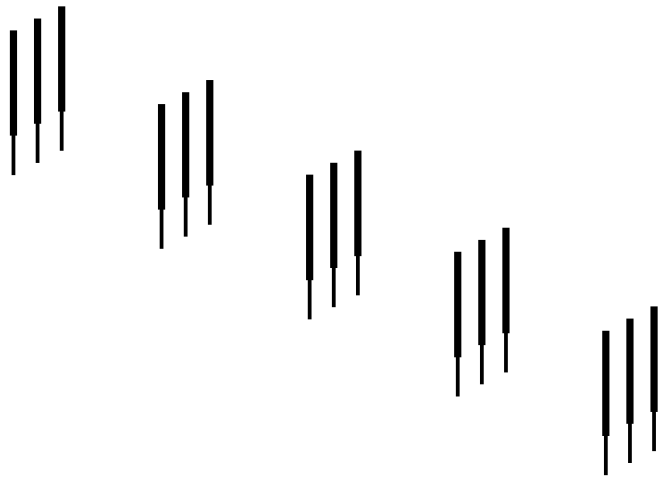
Group: Sipovi
Beam Results: max M3= 1862 / min M3= -1862 kNm

Load 14: Sy



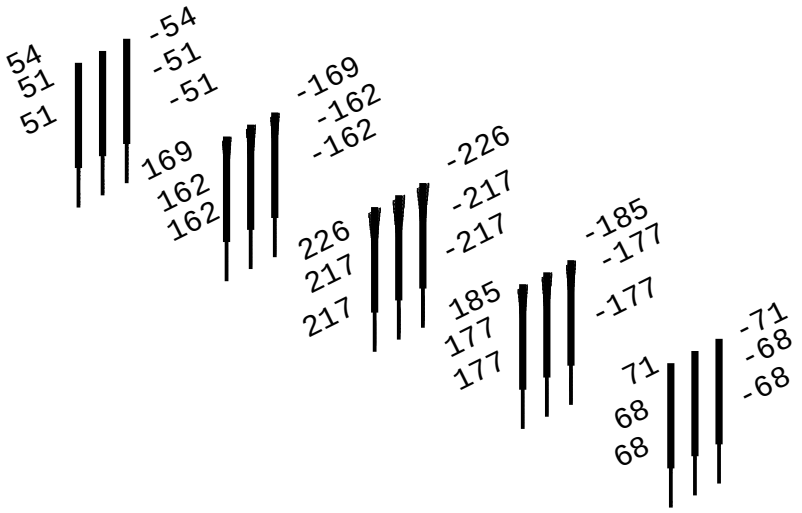
Group: Sipovi
Beam Results: max M2= 9534 / min M2= -9534 kNm

Load 14: Sy



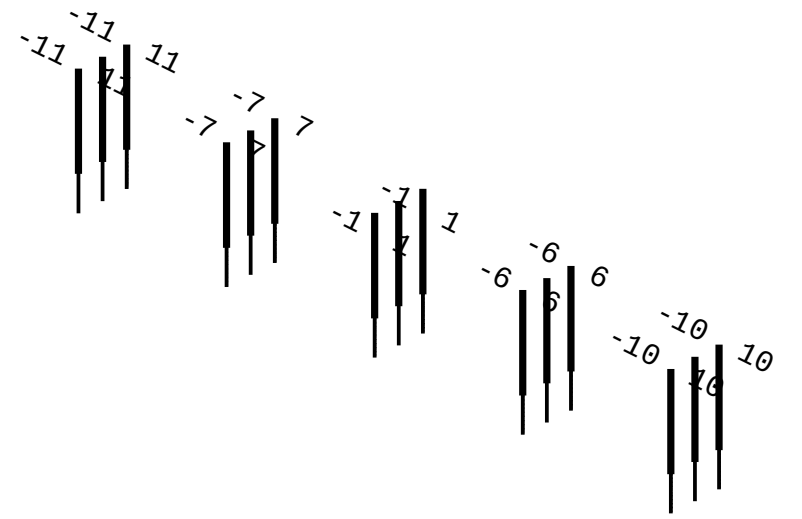
Group: Sipovi
Beam Results: max M1= 899 / min M1= -899 kNm

Load 14: Sy



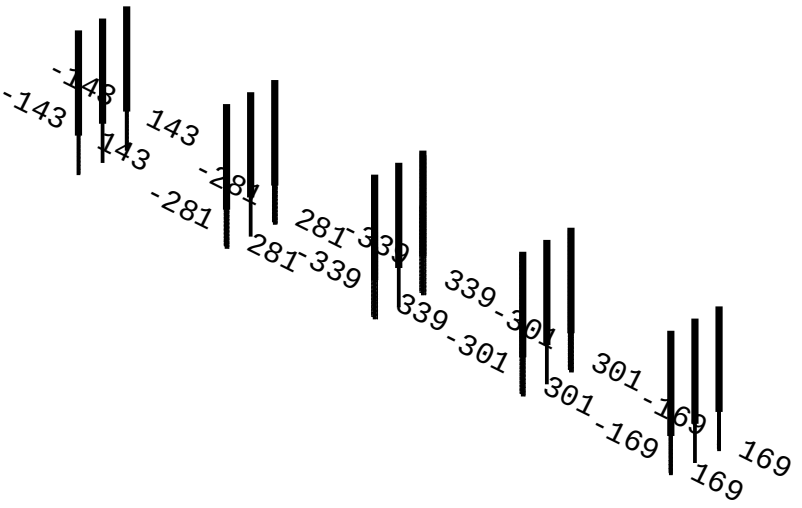
Group: Sipovi
Beam Results: max V3= 309 / min V3= -309 kN

Load 14: Sy



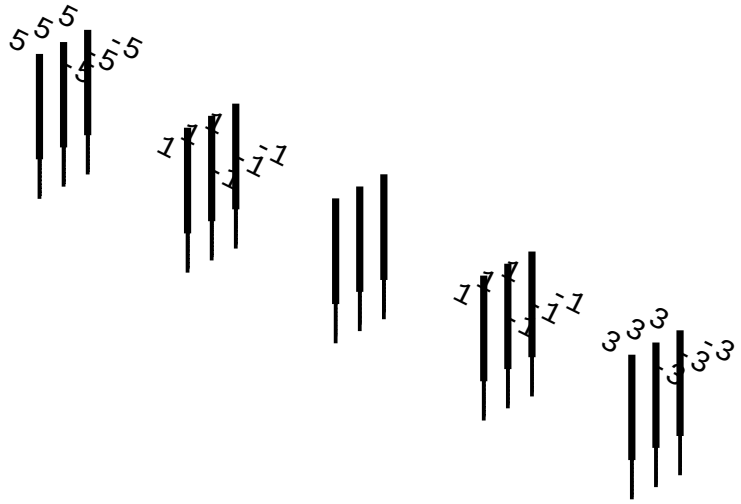
Group: Sipovi
Beam Results: max V2= 1328 / min V2= -1328 kN

Load 14: Sy



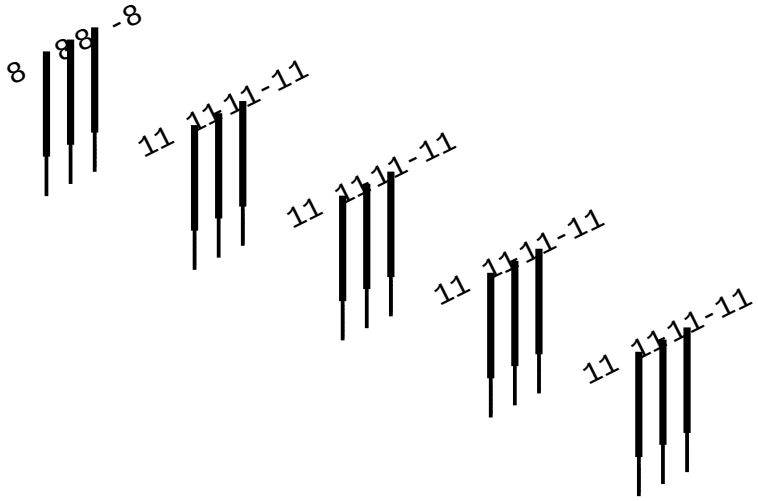
Group: Sipovi
Beam Results: max N1= 992 / min N1= -992 kN

Load 15: Sz



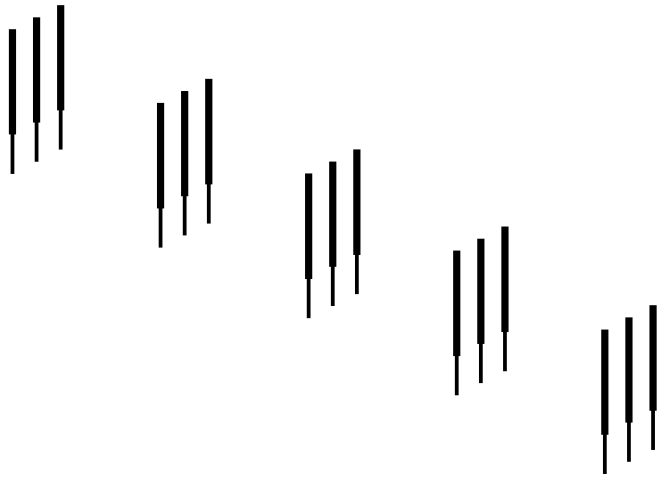
Group: Sipovi
Beam Results: max M3= 293 / min M3= -293 kNm

Load 15: Sz



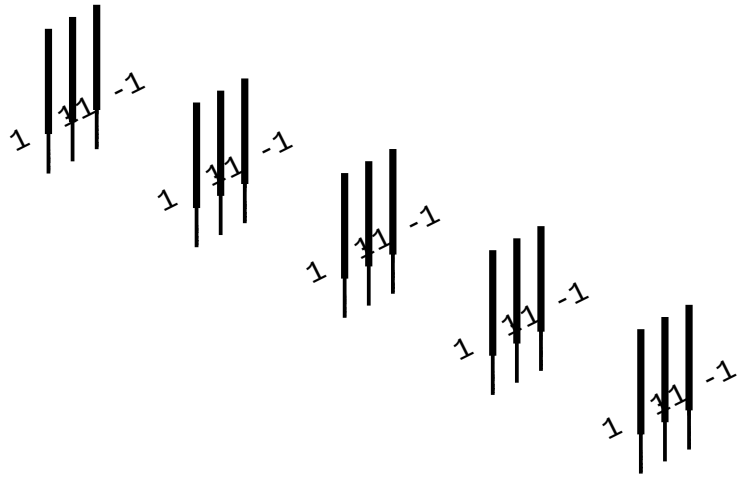
Group: Sipovi
Beam Results: max M2= 44 / min M2= -44 kNm

Load 15: Sz



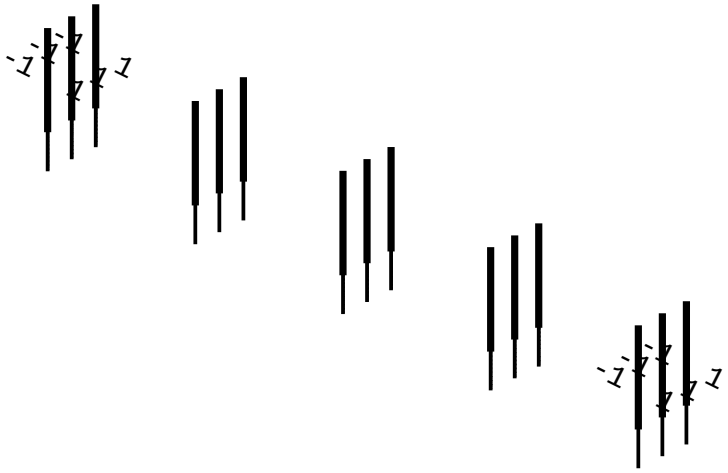
Group: Sipovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 15: Sz



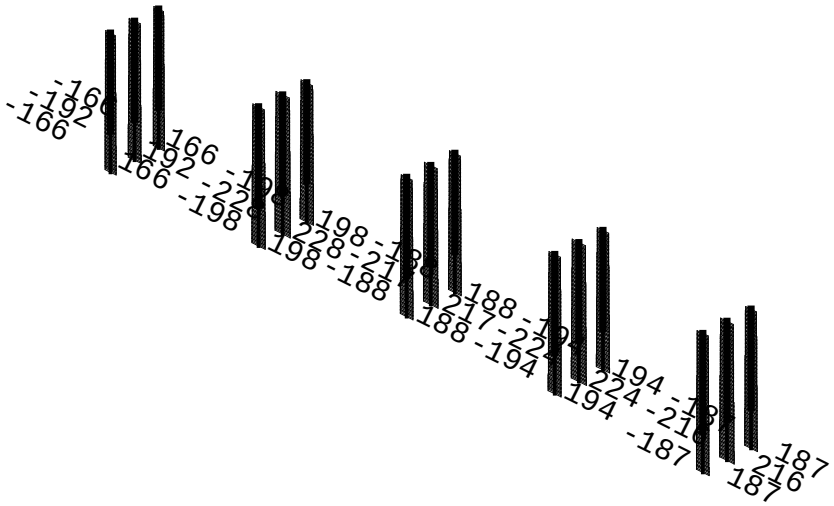
Group: Sipovi
Beam Results: max V3= 9 / min V3= -9 kN

Load 15: Sz



Group: Sipovi
Beam Results: max V2= 162 / min V2= -162 kN

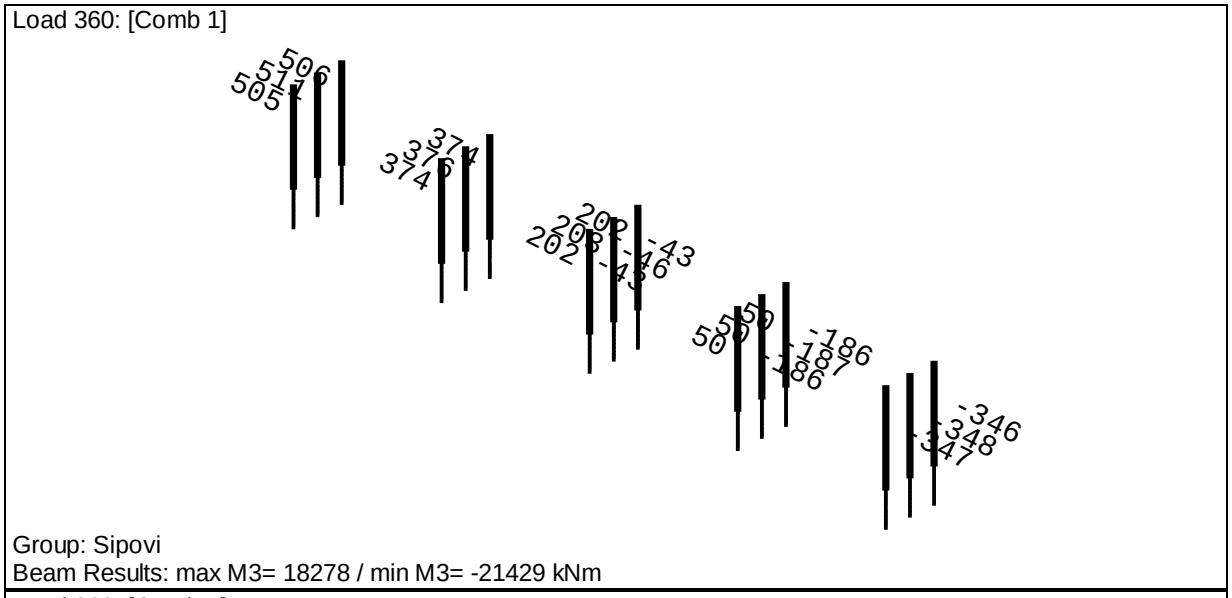
Load 15: Sz

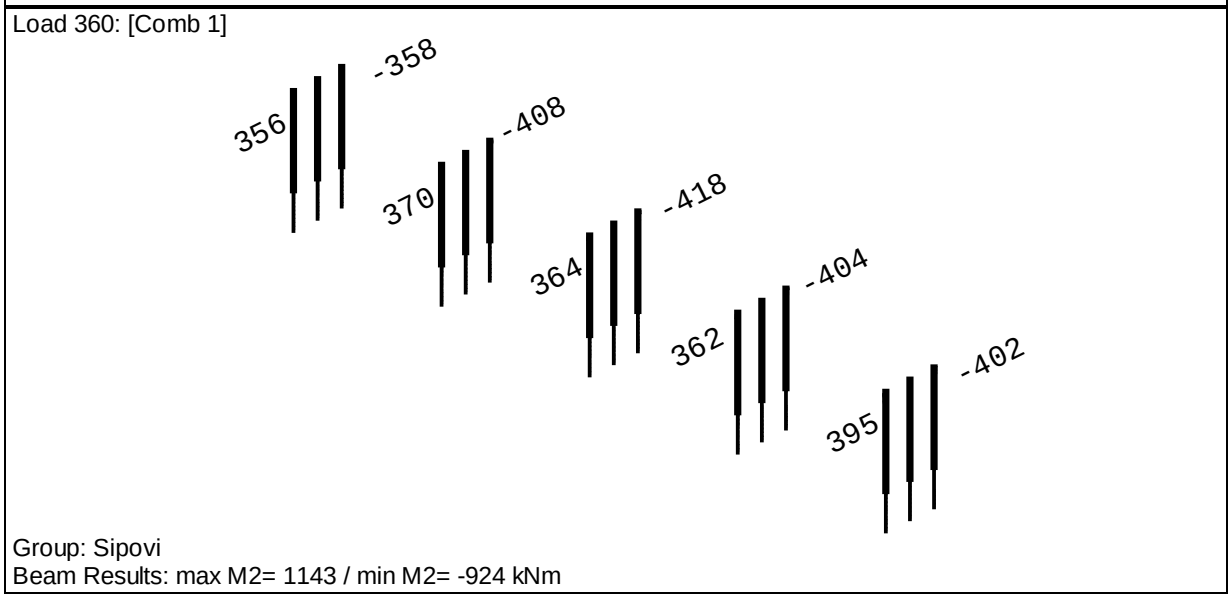


Group: Sipovi
Beam Results: max N1= 236 / min N1= -236 kN

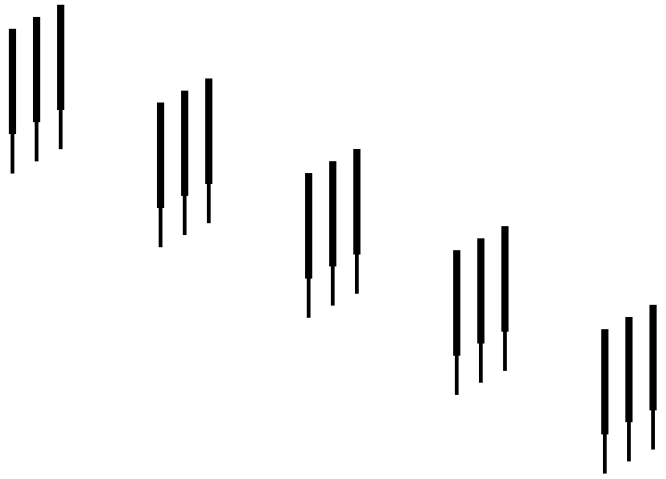
4.6.4.2 **Димензионисање /** Reinforcement design

Comb 1



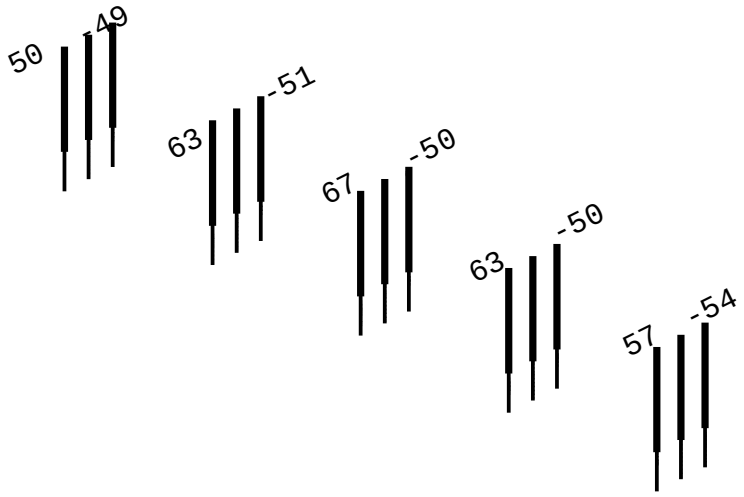


Load 360: [Comb 1]



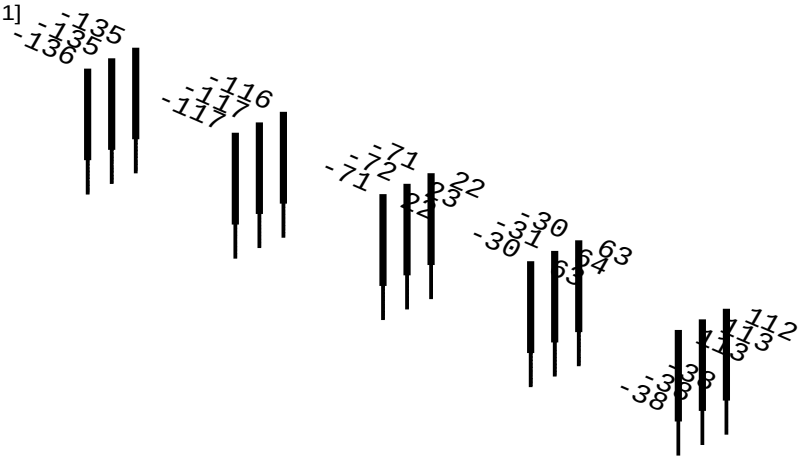
Group: Sipovi
Beam Results: max M1= 311 / min M1= -315 kNm

Load 360: [Comb 1]



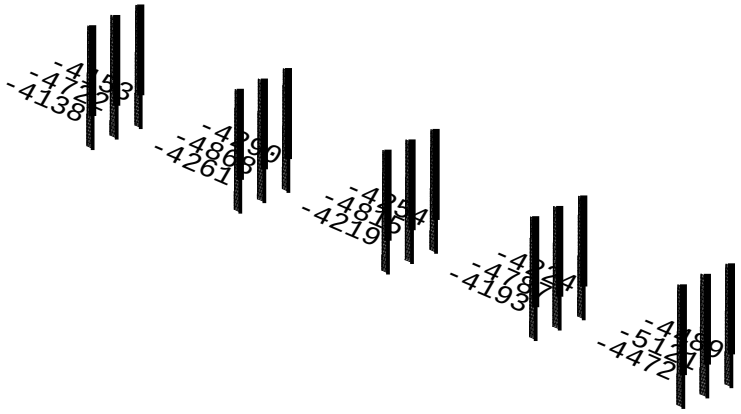
Group: Sipovi
Beam Results: max V3= 219 / min V3= -192 kN

Load 360: [Comb 1]



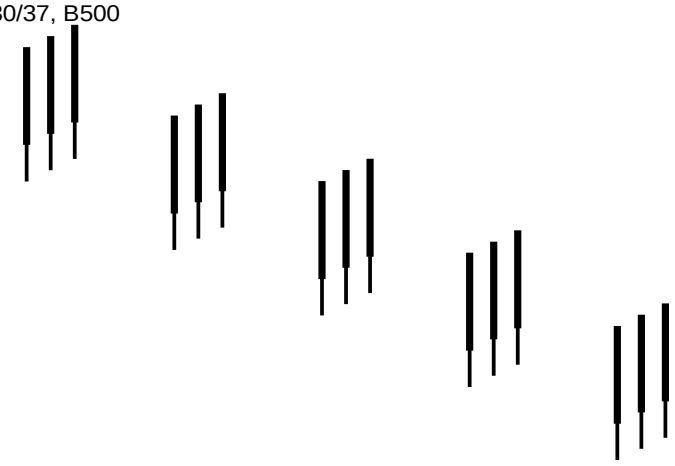
Group: Sipovi
Beam Results: max V2= 5648 / min V2= -6160 kN

Load 360: [Comb 1]



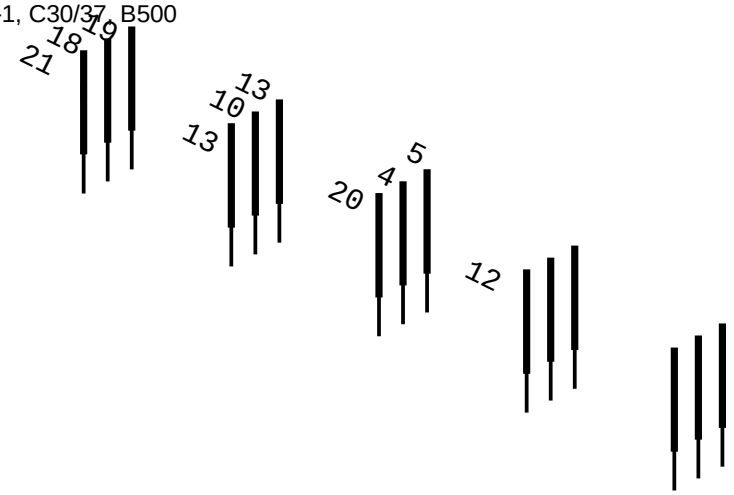
Group: Sipovi
Beam Results: max N1= 548 / min N1= -5605 kN

Governing load:
SRPS EN 1992-1-1, C30/37, B500



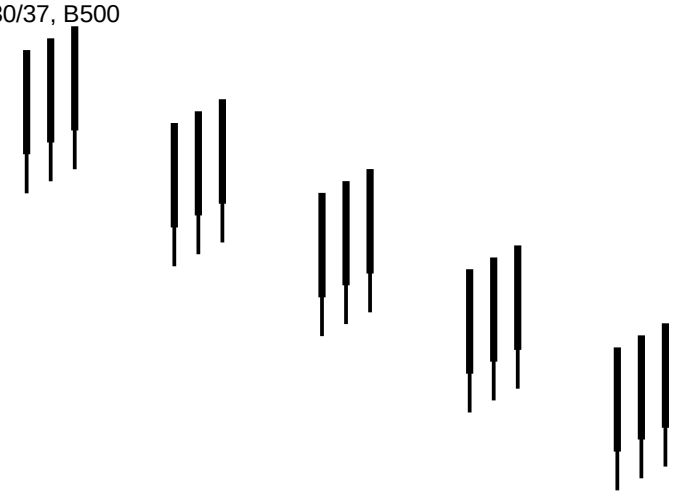
Group: Sipovi
Beam reinforcement: Aa,br

Governing load:
SRPS EN 1992-1-1, C30/37, B500



Group: Sipovi
Beam reinforcement: Aa2/Aa1

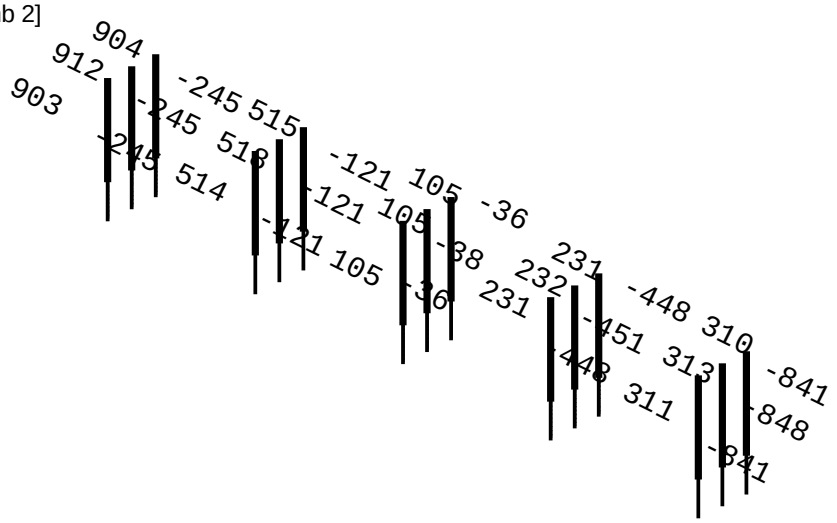
Governing load:
SRPS EN 1992-1-1, C30/37, B500



Group: Sipovi
Beam reinforcement: Aa,br

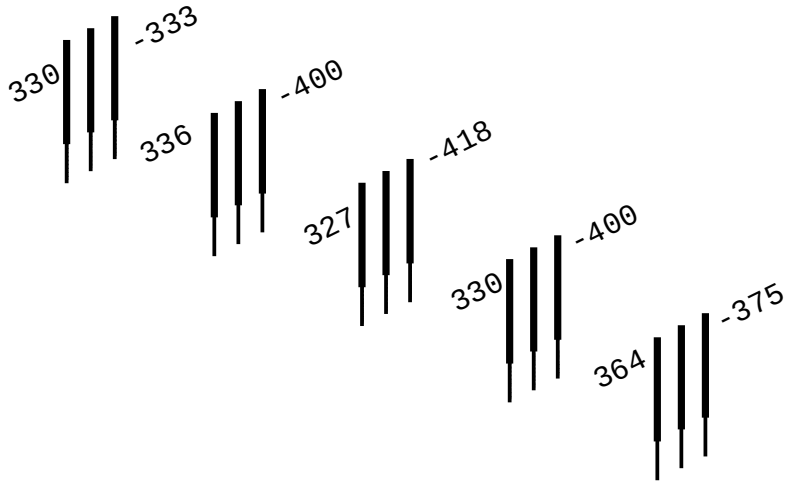
Comb 2

Load 361: [Comb 2]



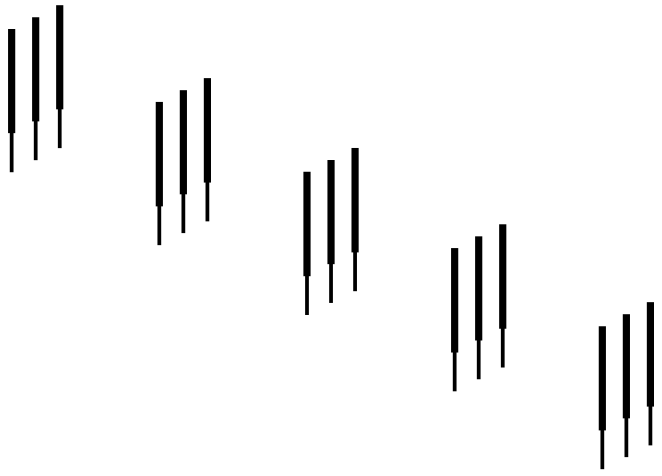
Group: Sipovi
Beam Results: max M3= 18087 / min M3= -23149 kNm

Load 361: [Comb 2]



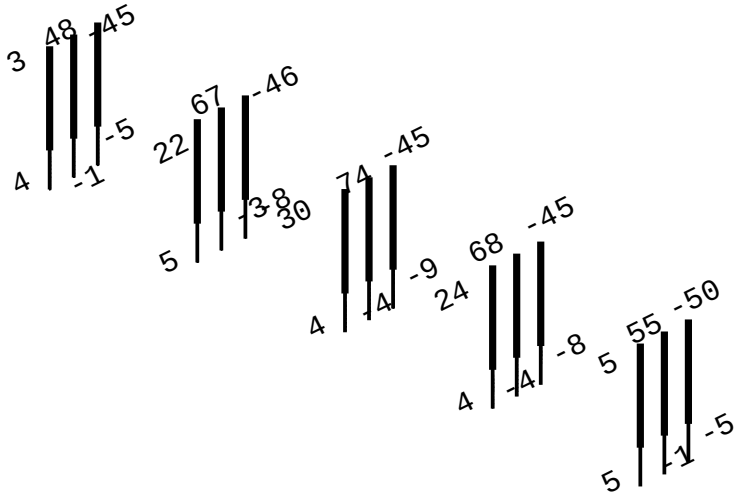
Group: Sipovi
Beam Results: max M2= 1197 / min M2= -1470 kNm

Load 361: [Comb 2]



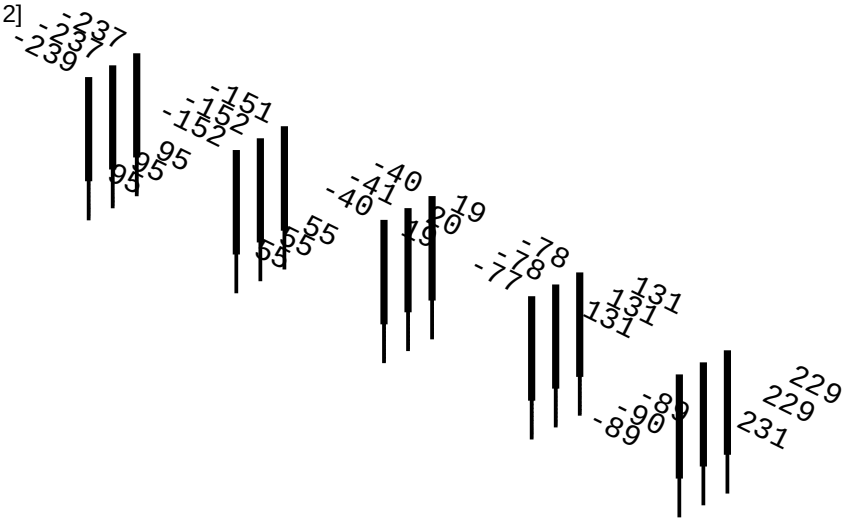
Group: Sipovi
Beam Results: max M1= 515 / min M1= -521 kNm

Load 361: [Comb 2]



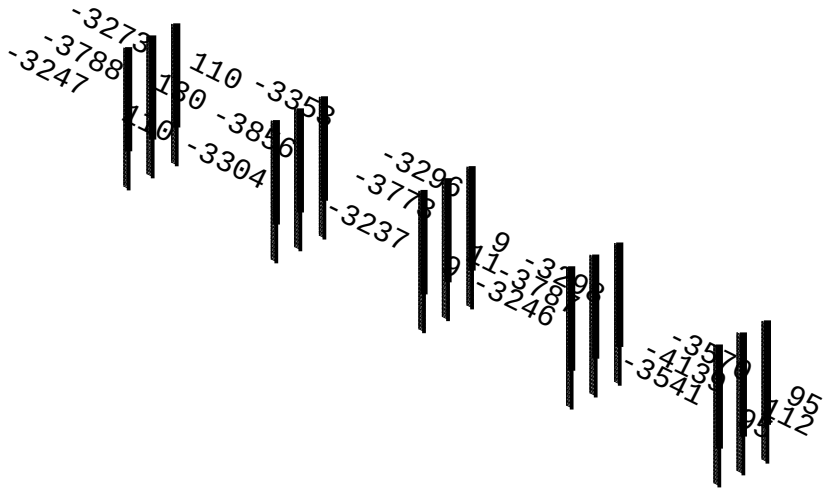
Group: Sipovi
Beam Results: max V3= 261 / min V3= -259 kN

Load 361: [Comb 2]



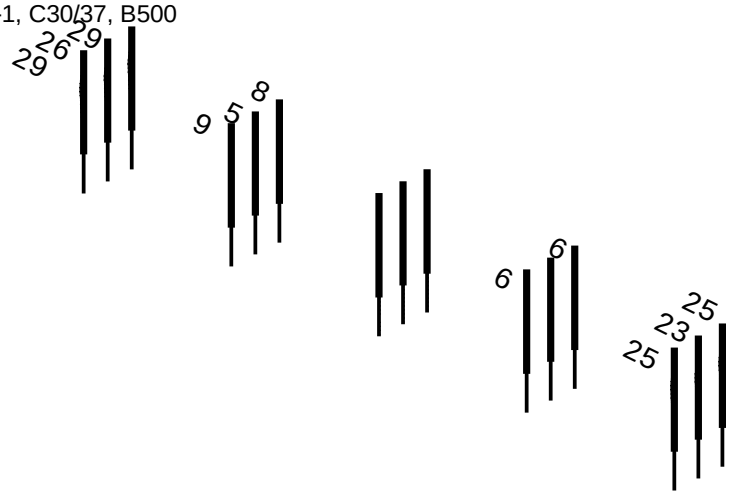
Group: Sipovi
Beam Results: max V2= 5057 / min V2= -5572 kN

Load 361: [Comb 2]



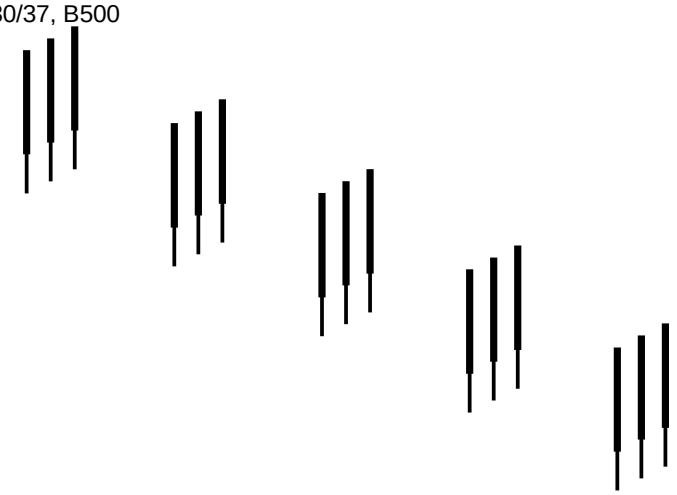
Group: Sipovi
Beam Results: max N1= 1116 / min N1= -5188 kN

Governing load:
SRPS EN 1992-1-1, C30/37, B500



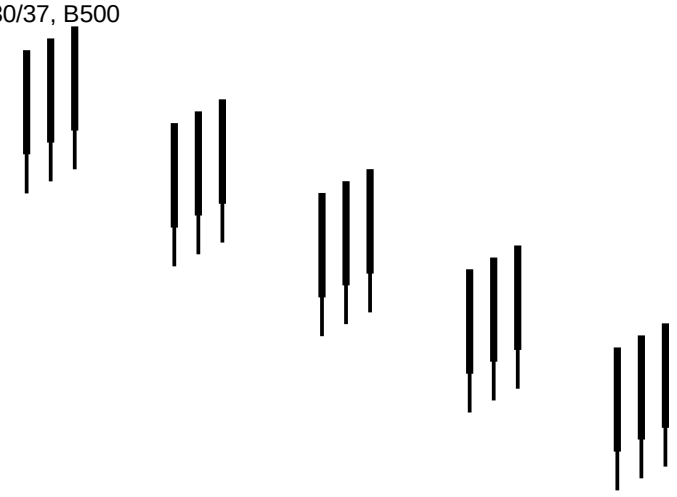
Group: Sipovi
Beam reinforcement: Aa2/Aa1

Governing load:
SRPS EN 1992-1-1, C30/37, B500



Group: Sipovi
Beam reinforcement: Aa3/Aa4

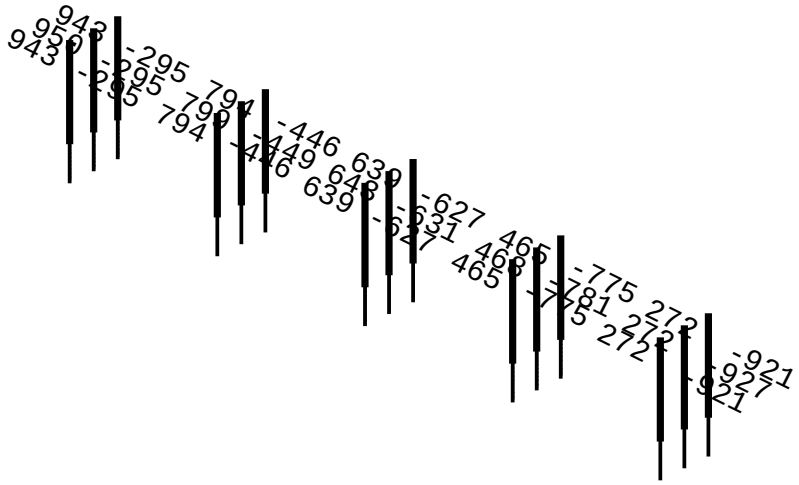
Governing load:
SRPS EN 1992-1-1, C30/37, B500



Group: Sipovi
Beam reinforcement: Aa,br

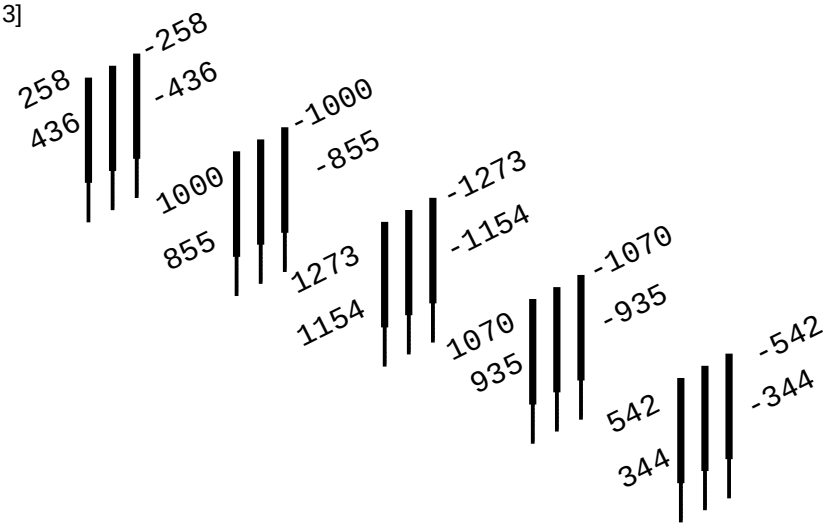
Comb 3

Load 362: [Comb 3]



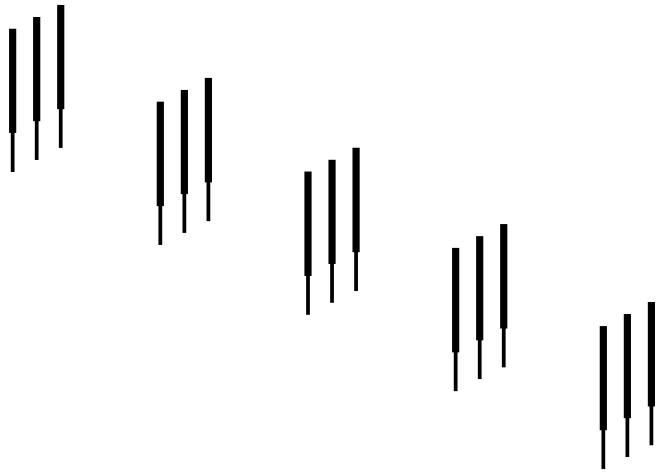
Group: Sipovi
Beam Results: max M3= 8579 / min M3= -13193 kNm

Load 362: [Comb 3]



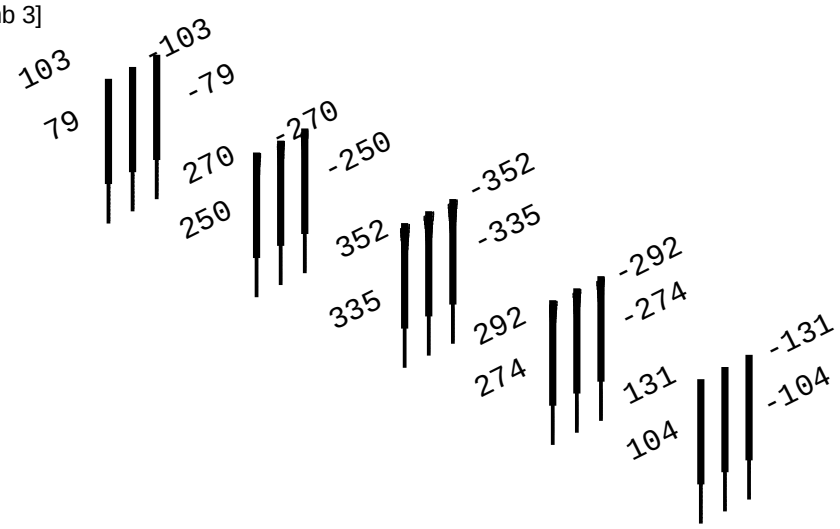
Group: Sipovi
Beam Results: max M2= 13610 / min M2= -13610 kNm

Load 362: [Comb 3]



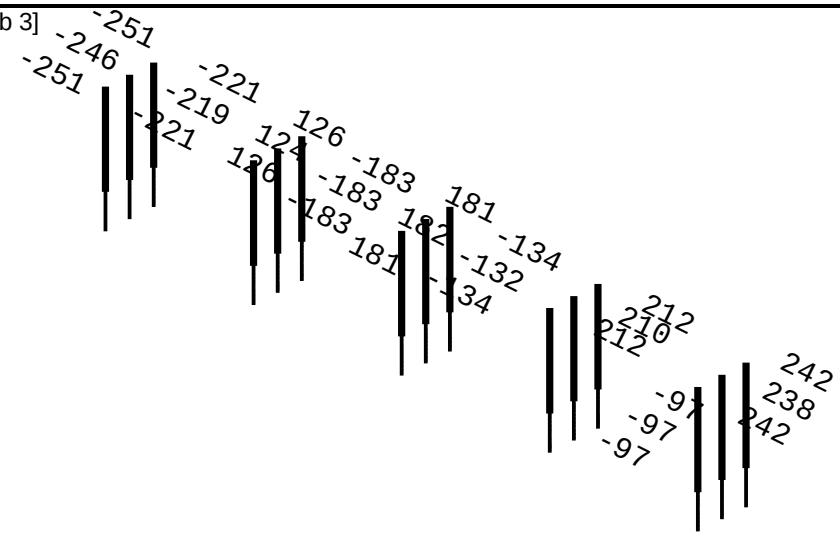
Group: Sipovi
Beam Results: max M1= 1339 / min M1= -1339 kNm

Load 362: [Comb 3]



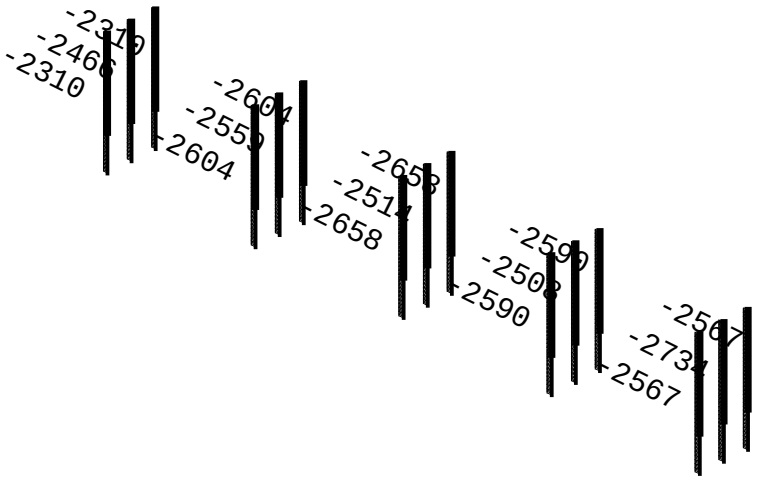
Group: Sipovi
Beam Results: max V3= 569 / min V3= -569 kN

Load 362: [Comb 3]



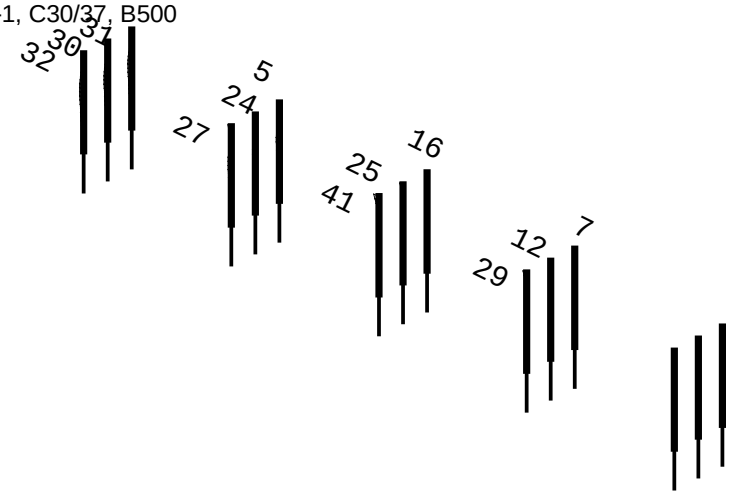
Group: Sipovi
Beam Results: max V2= 3209 / min V2= -3209 kN

Load 362: [Comb 3]



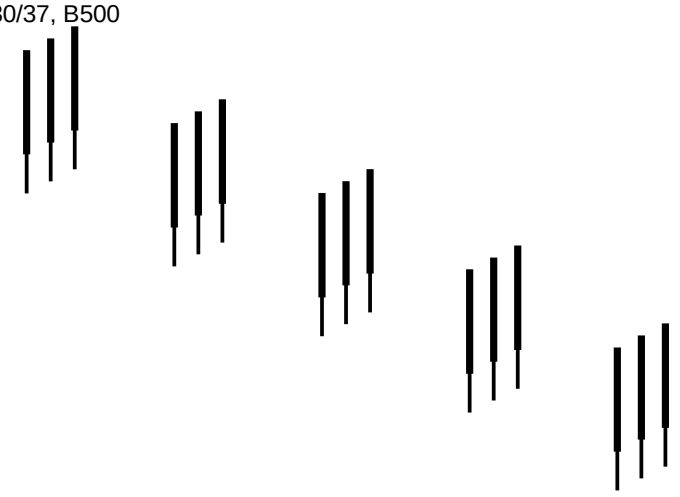
Group: Sipovi
Beam Results: max N1= 540 / min N1= -4490 kN

Governing load:
SRPS EN 1992-1-1, C30/37, B500



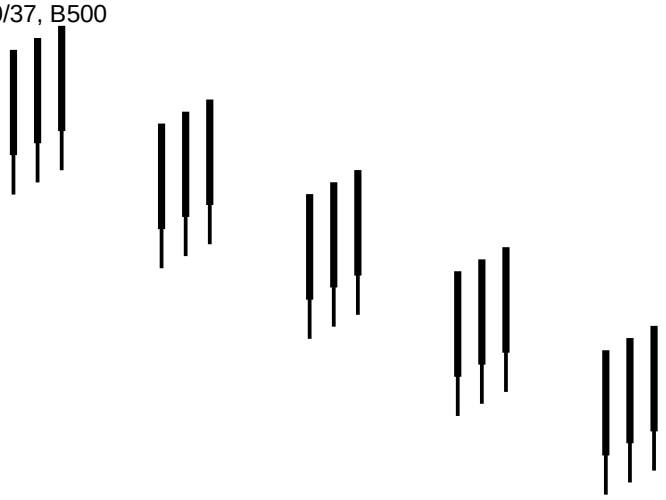
Group: Sipovi
Beam reinforcement: Aa2/Aa1

Governing load:
SRPS EN 1992-1-1, C30/37, B500



Group: Sipovi
Beam reinforcement: Aa3/Aa4

Governing load:
SRPS EN 1992-1-1, C30/37, B500



Group: Sipovi
Beam reinforcement: Aa,br

Потребна арматура / required reinforcement

Вертикална арматура / Vertical reinforcement

Aa =41 cm2

Смичућа арматура / Shear reinforcement

Aa = 0 cm2/m

Minimalna armatura / Minimum reinforcement

Φ120 cm → Ab = 11304 cm2

Aa,min = 0.0025xAc = 0.0025x11304 = 28.26 cm2

Usvojena armatura / provided reinforcement :

Podužna armatura / Longitudinal reinforcement

18Φ20/20 (Aa = 56.52 cm2) **Вертикална арматура** / Vertical reinforcement

Φ12/15 (Aa = 7.54 cm2/m) → **узенгије** / stirrups

Maksimalna sila u šipu / Maximal axial force

	ULS	SLS
	Nmax	Nmax
S2	4078	3018
S3	4216	3127
S4	4167	3089
S5	4136	3069
S6	4475	3304

S8-S13

4.6.5 Анализа оптерецења / Load analyses

Размарана су следећа оптерећења / The following loads were considered :

- **G – Сопствена тежина /** Self weight
- **dG – Додатно стално оптерећење /** Superimposed load
- **Sk – Скупљање /** Creep
- **TS - Двоосовински тандем систем концентрисаних сила /** Tandem system
- **UDL - једнакоподељено површинско оптерећење /** uniformly distributed load
- **K – Силе кочења /** Braking forces
- **T – Температурна промена** / Uniform temperature change
- **dT – Температурна разлика** / Linear temperature change
- **W – Ветар** / wind
- **Sx,y,z – Сеизмика /** Seizmic load

Kombinacije opterećenja / Load combinations :

Comb1 → Доминантно возило / Dominant live load

$$\sum = 1.35(G+dG) + 1.0Sk + 1.35Ts + 1.35UDL + 1.35K + 0.9W$$

Comb2 → Доминантна температура / Dominant temperature load

$$\sum = 1.35(G+dG) + 1.0Sk + 1.01Ts + 0,54UDL + 0,54K + 1.5W + 1.5T$$

Comb3 → Доминантна сеизмика / Dominant seizmic load

$$\sum = 1.0(G+dG) + 1.0Sk + 1.0(20\%)UDL + 1.0Si + 0.3Sik$$

4.6.6 **Стубови /** Piers

4.6.6.1 **Модална анализа /** Modal analyses

Load factors for mass calculations

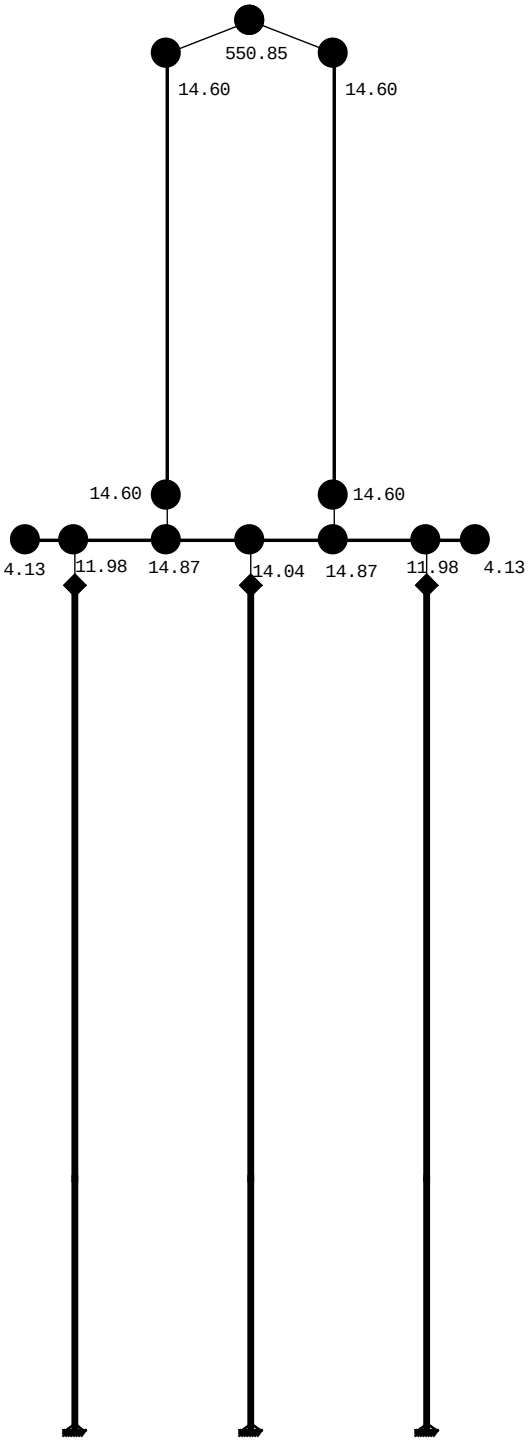
No	Name	Factor
1	Sopostvena tezina (g)	1.00
2	Dodatno stalno	1.00
3	UDL (20%)	1.00
4	Skupljanje	0.00
5	TS	0.00
6	UDL	0.00
7	Kocenje	0.00
8	T+34	0.00
9	T-31	0.00
10	dt+12.3	0.00
11	dt-8	0.00
12	Vetar	0.00

Mass distribution per levels

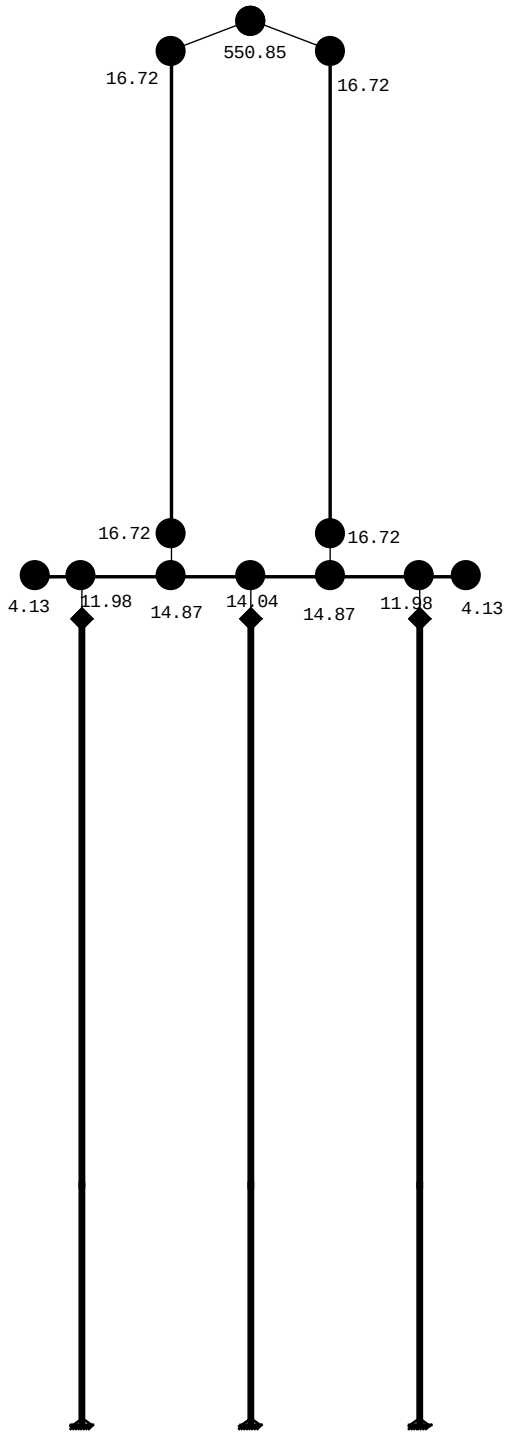
Level	Z [m]	X [m]	Y [m]	Mass [T]	T/m^2
	0.00	31.09	-8.64	3837.50	
Total:	0.00	31.09	-8.64	3837.50	

Natural frequency of structure

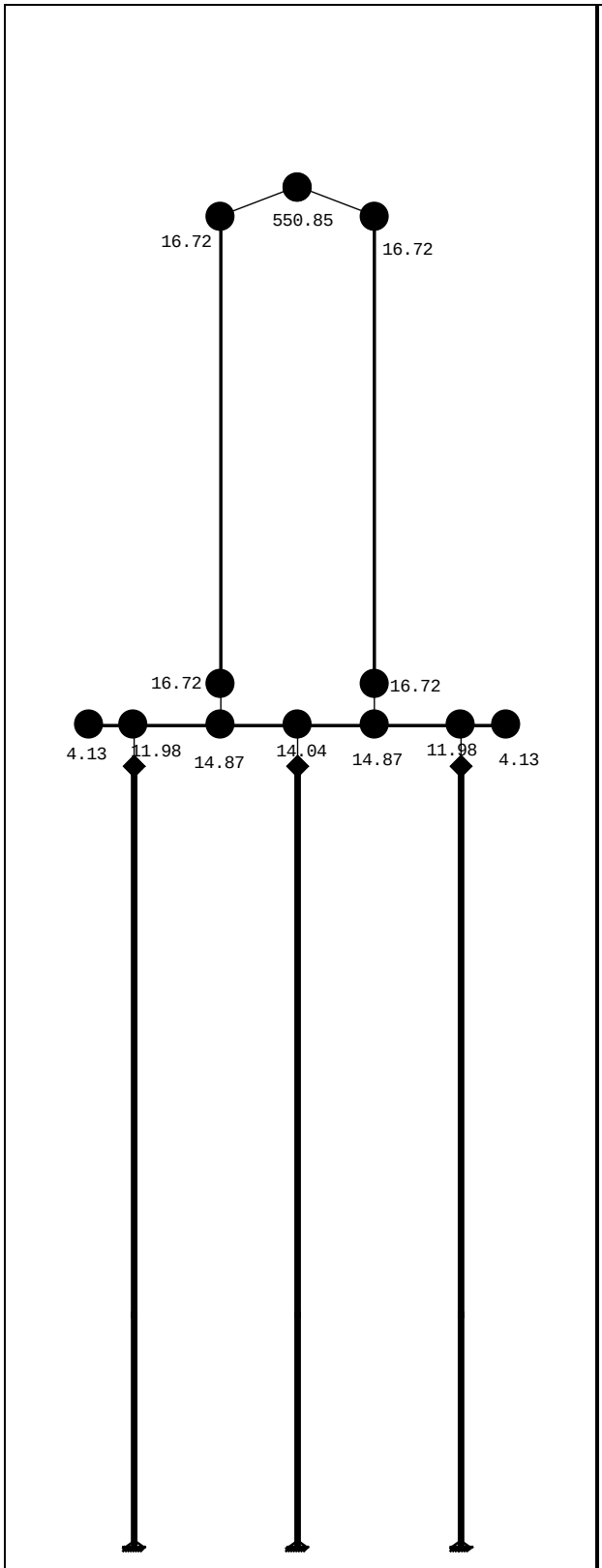
No	T [s]	f [Hz]
1	**1.3144**	**0.7608**
2	**0.7285**	**1.3726**
3	0.3251	3.0759
4	0.1780	5.6184
5	0.1753	5.7052
6	0.1718	5.8214
7	0.1614	6.1965
8	0.1602	6.2405
9	0.1602	6.2433
10	0.1468	6.8131
11	0.1337	7.4789
12	0.1337	7.4813
13	0.1316	7.6008
14	**0.1310**	**7.6320**
15	0.1297	7.7084



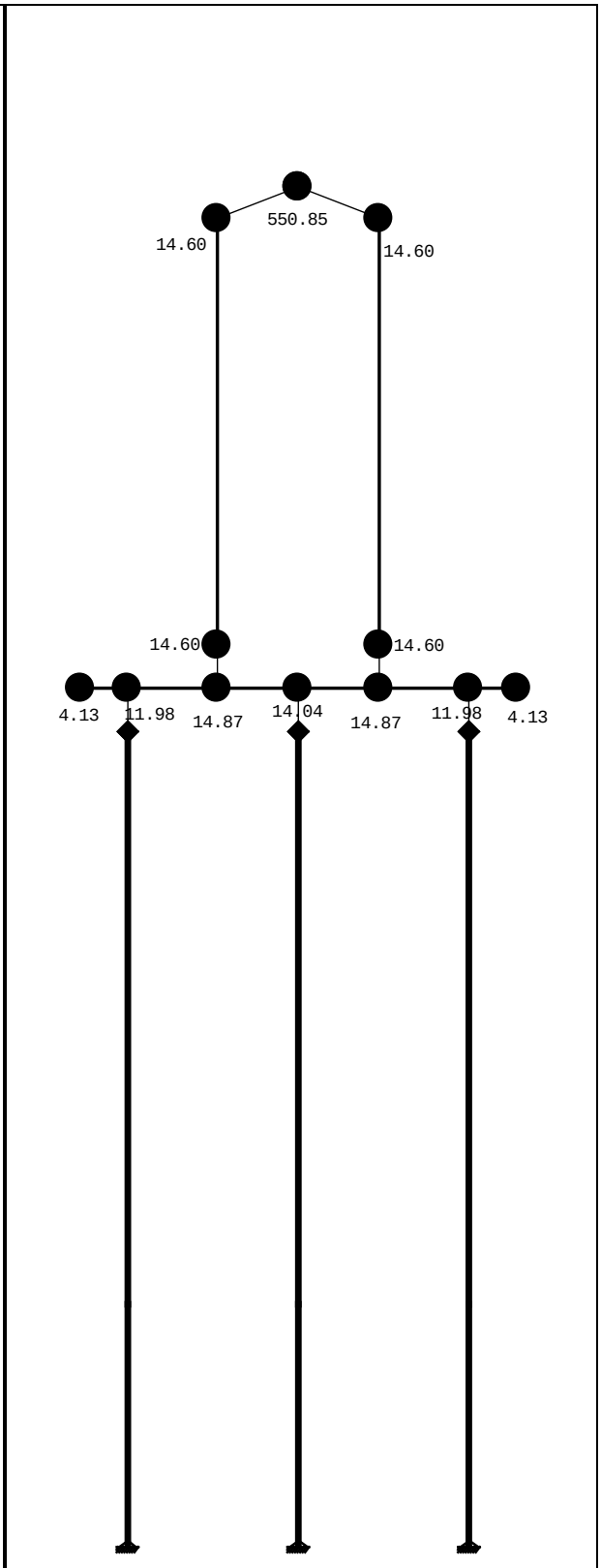
Frame: V_1 - Group: model
Mass position



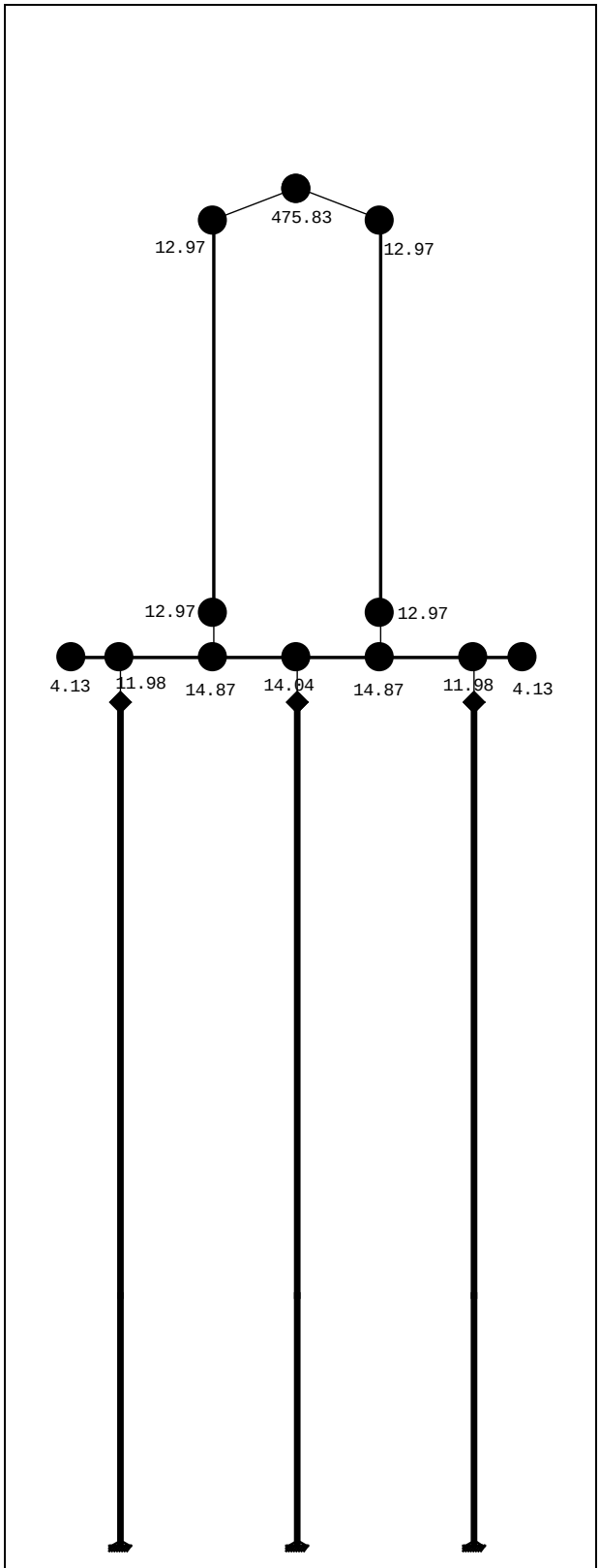
Frame: V_2 - Group: model
Mass position



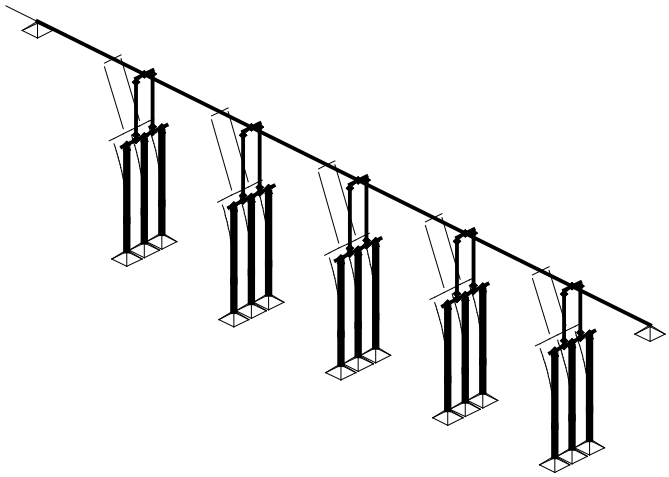
Frame: V_3 - Group: model
Mass position



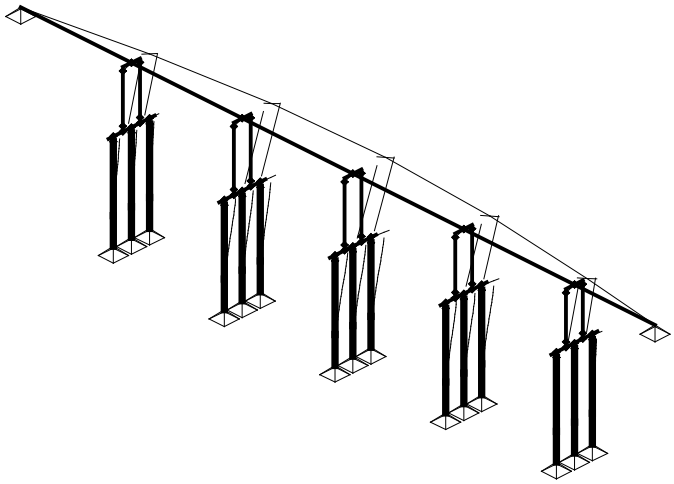
Frame: V_4 - Group: model
Mass position



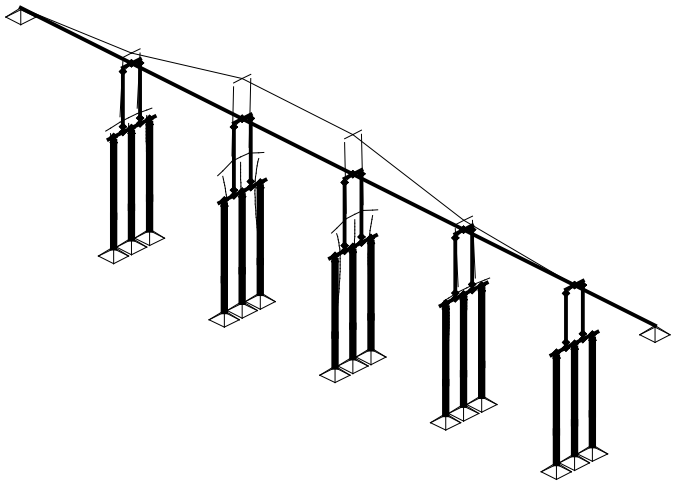
Frame: V_5 - Group: model
Mass position



Isometric
Modals 1/15 [T=1.3144sec / f=0.76Hz]



Isometric
Modals 2/15 [T=0.7285sec / f=1.37Hz]



Isometric
Modals 14/15 [T=0.1310sec / f=7.63Hz]

Seismic analysis: EC8 (EN 1998)

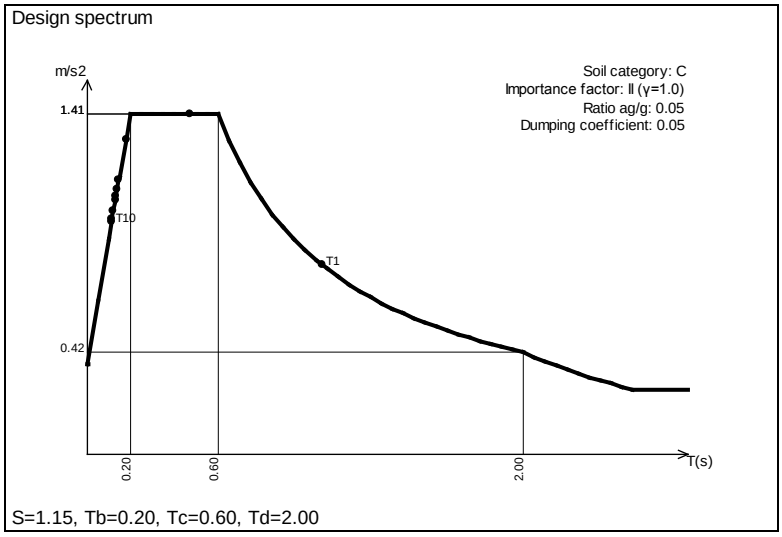
Soil category:	C
Importance factor:	II (γ=1.0)
Ratio ag/g:	0.05
Dumping coefficient:	0.05

Earthquake directional factors:

Load case	Angle α[°]	k,α	k,α+90°	kz	q
Sx	0	1.000	0.000	0.000	1.000
Sy	90	1.000	0.000	0.000	1.000
Sz	0	0.000	0.000	1.000	1.000

Type of spectrum

Load case	S	Tb	Tc	Td	avg/ag
Sx	1.150	0.200	0.600	2.000	1.000
Sy	1.150	0.200	0.600	2.000	1.000
Sz	1.150	0.200	0.600	2.000	1.000

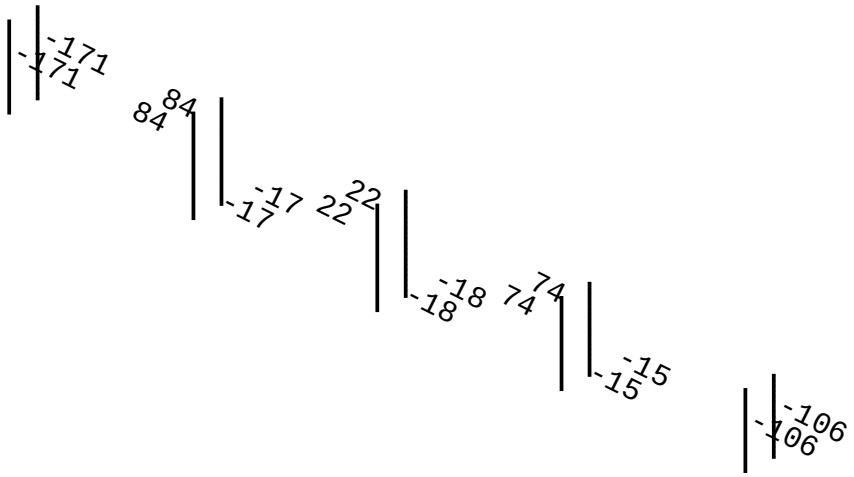


Distribution factors - mass involvement

Mode	U [α=0°]	U [α=90°]	U [α=0°]	U [Z]
1	84.28	0.00	84.28	0.00
2	0.00	69.99	0.00	0.00
3	0.00	0.02	0.00	0.00
4	0.84	0.00	0.84	0.01
5	0.00	10.00	0.00	0.00
6	0.03	0.00	0.03	0.01
7	0.21	0.00	0.21	0.00
8	2.30	0.00	2.30	0.01
9	5.76	0.00	5.76	0.00
10	0.00	2.30	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00
16	0.00	0.13	0.00	0.00
17	0.00	0.00	0.00	65.31
18	0.00	0.00	0.00	5.62
19	0.00	0.00	0.00	4.55
20	0.00	0.00	0.00	0.04
21	0.00	0.00	0.00	12.03
22	0.00	0.04	0.00	0.00
23	0.00	0.03	0.00	0.00
24	0.00	0.39	0.00	0.00
25	0.00	0.02	0.00	0.00
26	0.11	0.00	0.11	0.00
27	0.53	0.00	0.53	0.00
28	0.09	0.00	0.09	0.00
29	1.88	0.00	1.88	0.00
30	1.99	0.00	1.99	0.00
ΣU (%)	98.01	82.91	98.01	87.58

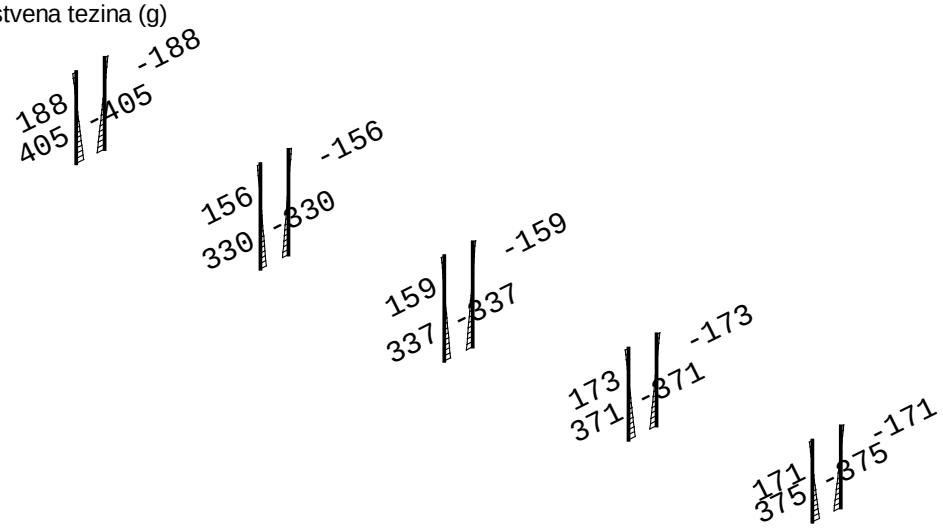
4.6.6.2 **Пресечне силе и деформације /** Internal forces and deformations

Load 1: Sopstvena tezina (g)



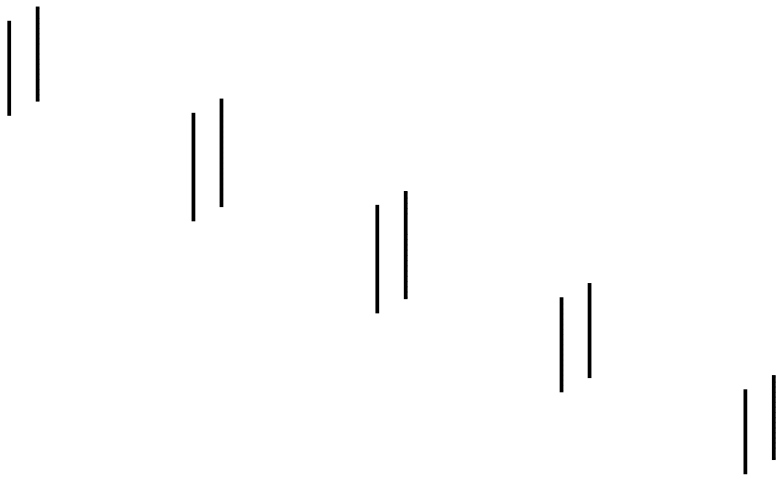
Group: Stubovi
Beam Results: max M3= 7308 / min M3= -9639 kNm

Load 1: Sopstvena tezina (g)



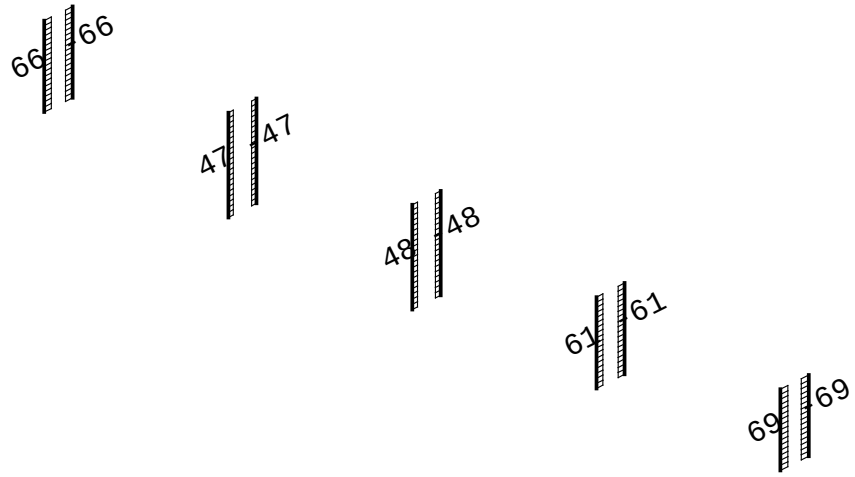
Group: Stubovi
Beam Results: max M2= 405 / min M2= -405 kNm

Load 1: Sopstvena tezina (g)



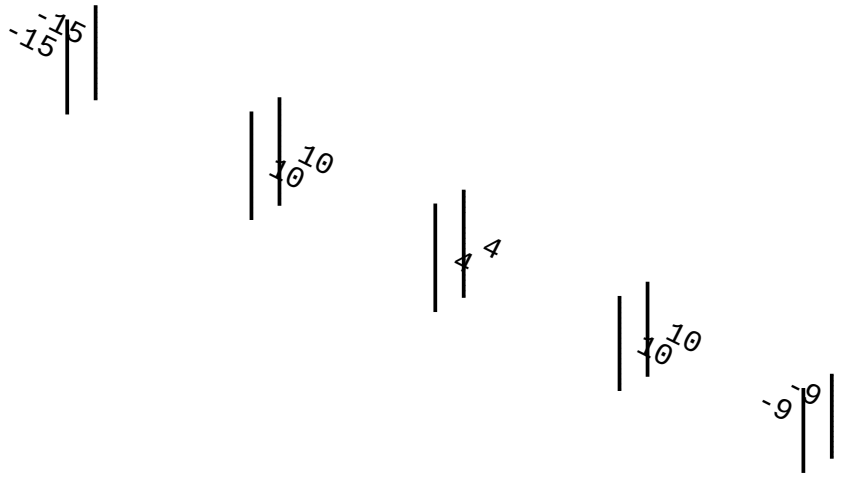
Group: Stubovi
Beam Results: max M1= 24 / min M1= -24 kNm

Load 1: Sopstvena tezina (g)



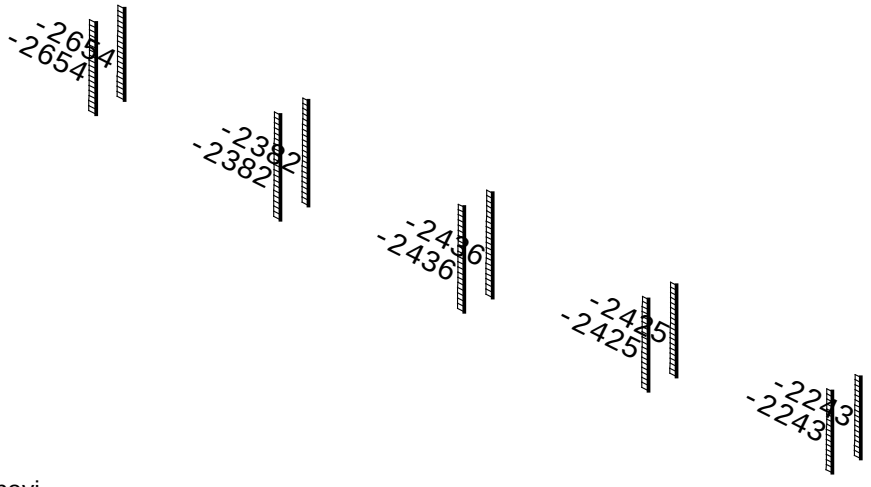
Group: Stubovi
Beam Results: max V3= 69 / min V3= -69 kN

Load 1: Sopstvena tezina (g)



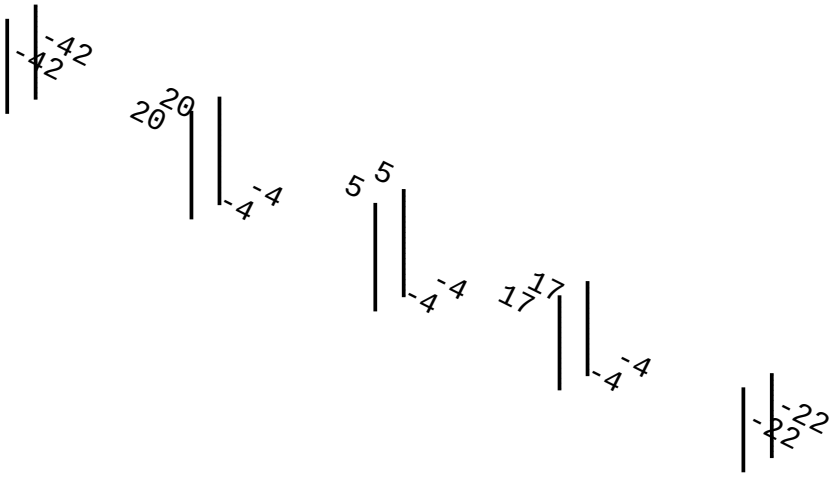
Group: Stubovi
Beam Results: max V2= 2541 / min V2= -2194 kN

Load 1: Sopstvena tezina (g)



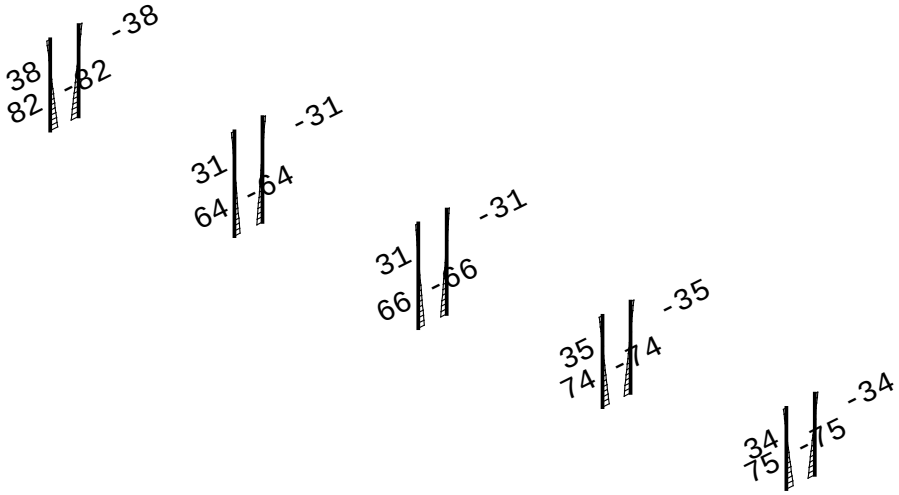
Group: Stubovi
Beam Results: max N1= 46 / min N1= -2654 kN

Load 2: Dodato stalno



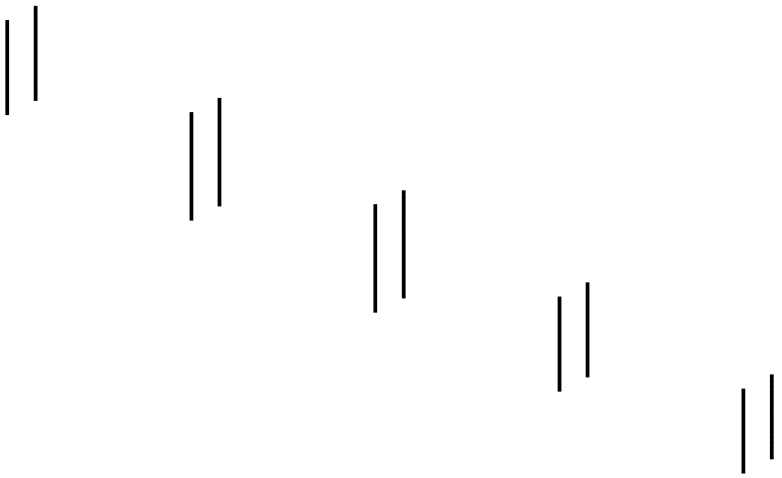
Group: Stubovi
Beam Results: max M3= 1727 / min M3= -2300 kNm

Load 2: Dodato stalno



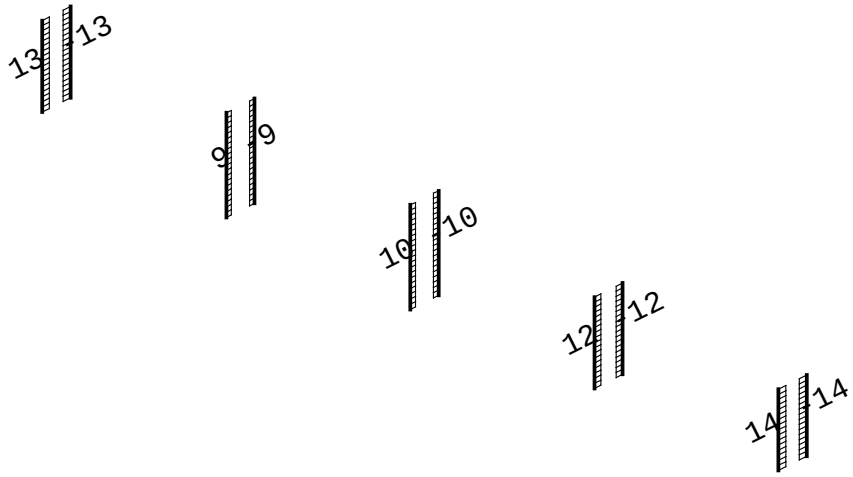
Group: Stubovi
Beam Results: max M2= 82 / min M2= -82 kNm

Load 2: Dodato stalno



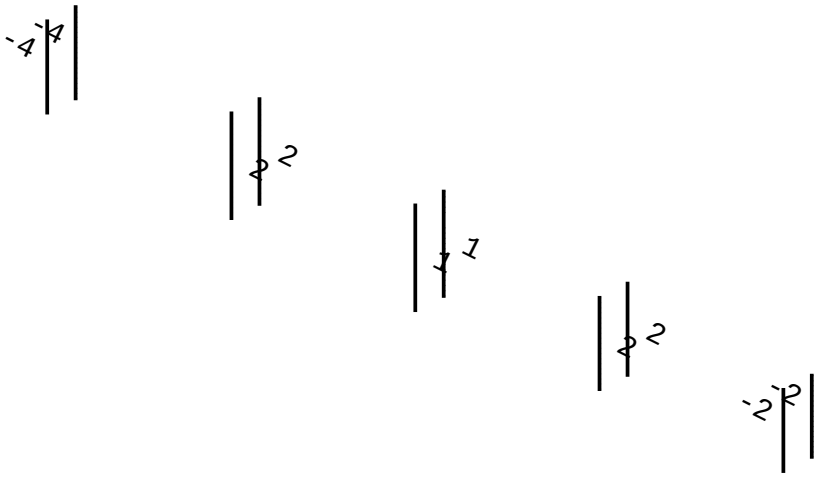
Group: Stubovi
Beam Results: max M1= 6 / min M1= -6 kNm

Load 2: Dodato stalno



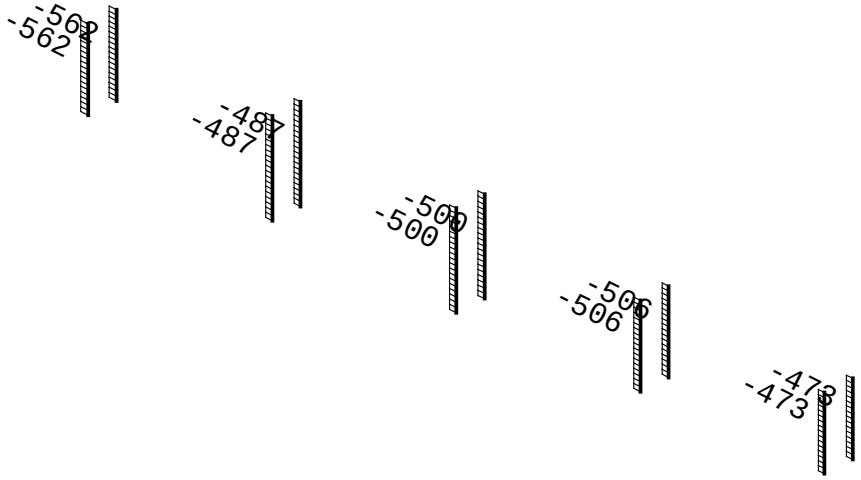
Group: Stubovi
Beam Results: max V3= 14 / min V3= -14 kN

Load 2: Dodato stalno



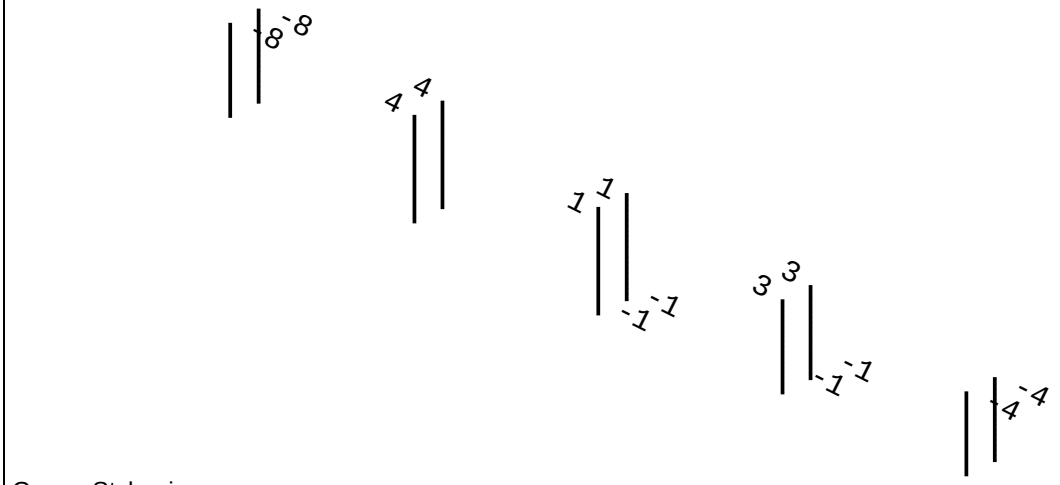
Group: Stubovi
Beam Results: max V2= 603 / min V2= -521 kN

Load 2: Dodato stalno



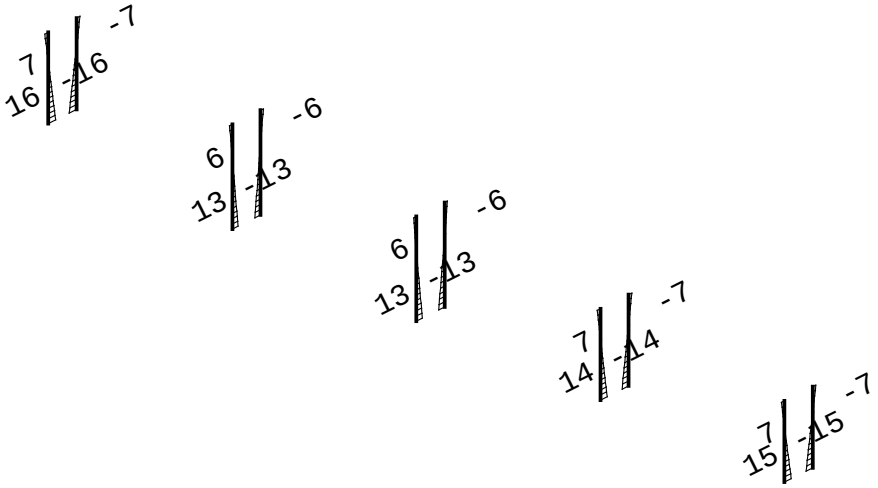
Group: Stubovi
Beam Results: max N1= 9 / min N1= -562 kN

Load 3: UDL (20%)



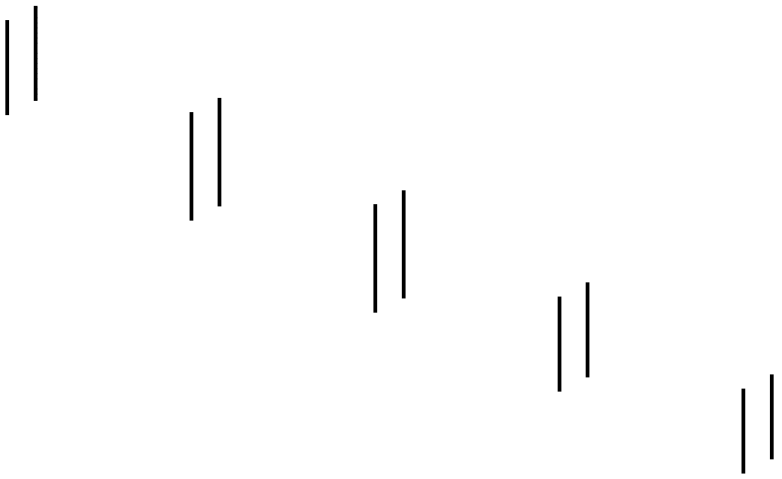
Group: Stubovi
Beam Results: max M3= 337 / min M3= -448 kNm

Load 3: UDL (20%)



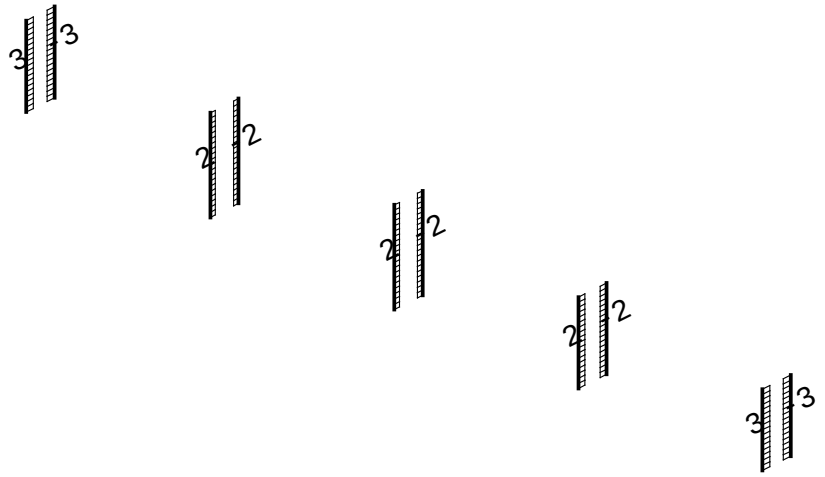
Group: Stubovi
Beam Results: max M2= 16 / min M2= -16 kNm

Load 3: UDL (20%)



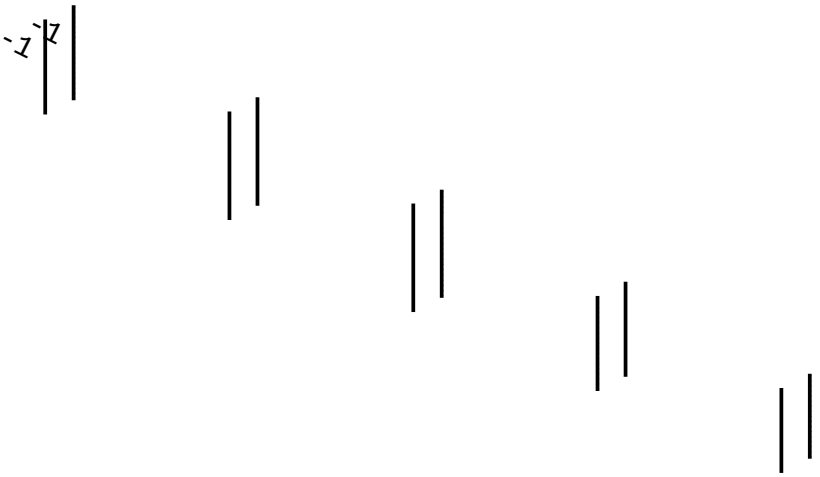
Group: Stubovi
Beam Results: max M1= 1 / min M1= -1 kNm

Load 3: UDL (20%)



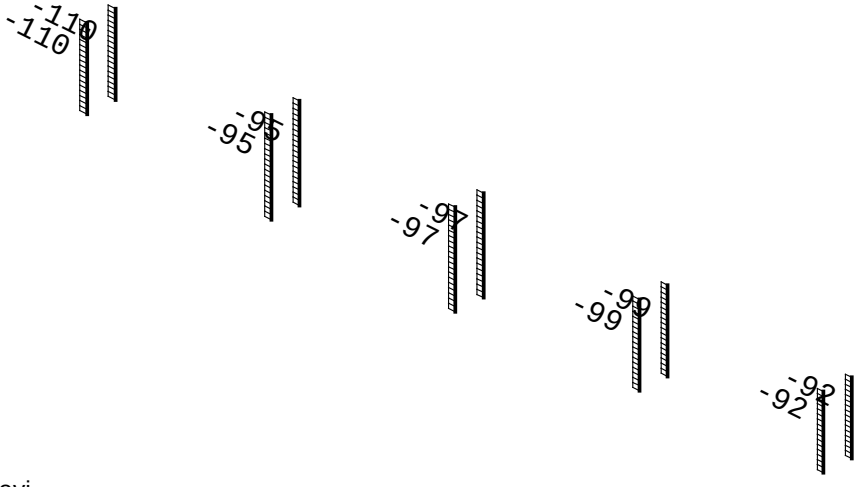
Group: Stubovi
Beam Results: max V3= 3 / min V3= -3 kN

Load 3: UDL (20%)



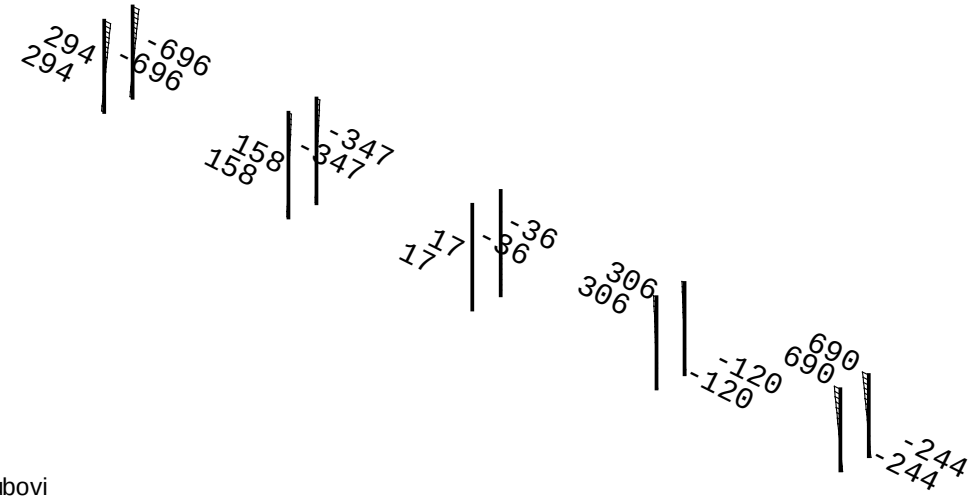
Group: Stubovi
Beam Results: max V2= 118 / min V2= -101 kN

Load 3: UDL (20%)



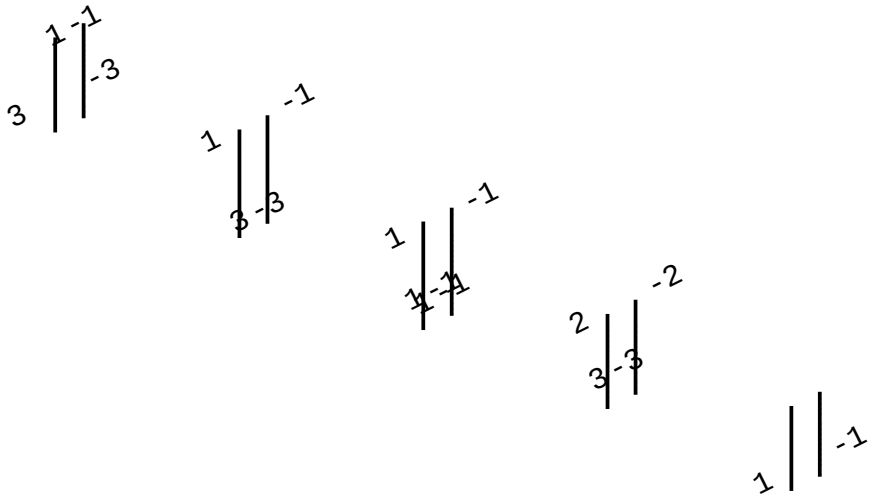
Group: Stubovi
Beam Results: max N1= 2 / min N1= -110 kN

Load 4: Skupljanje



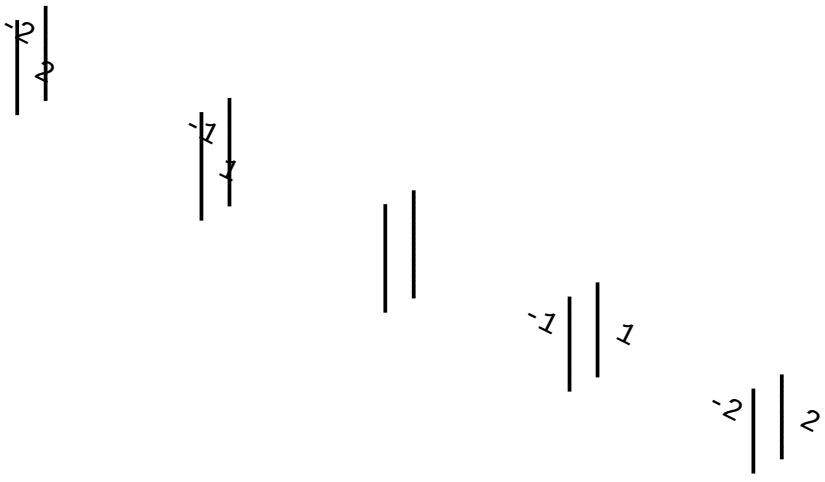
Group: Stubovi
Beam Results: max M3= 818 / min M3= -696 kNm

Load 4: Skupljanje



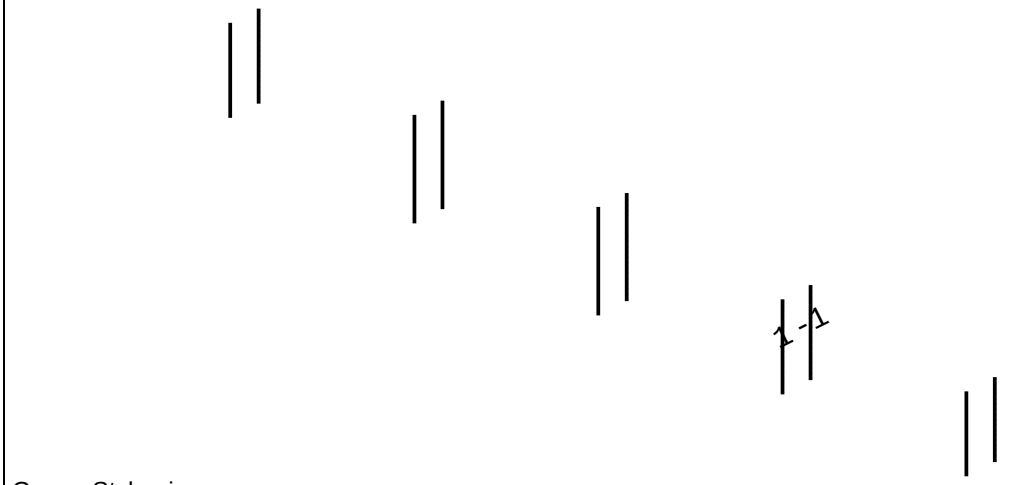
Group: Stubovi
Beam Results: max M2= 140 / min M2= -149 kNm

Load 4: Skupljanje



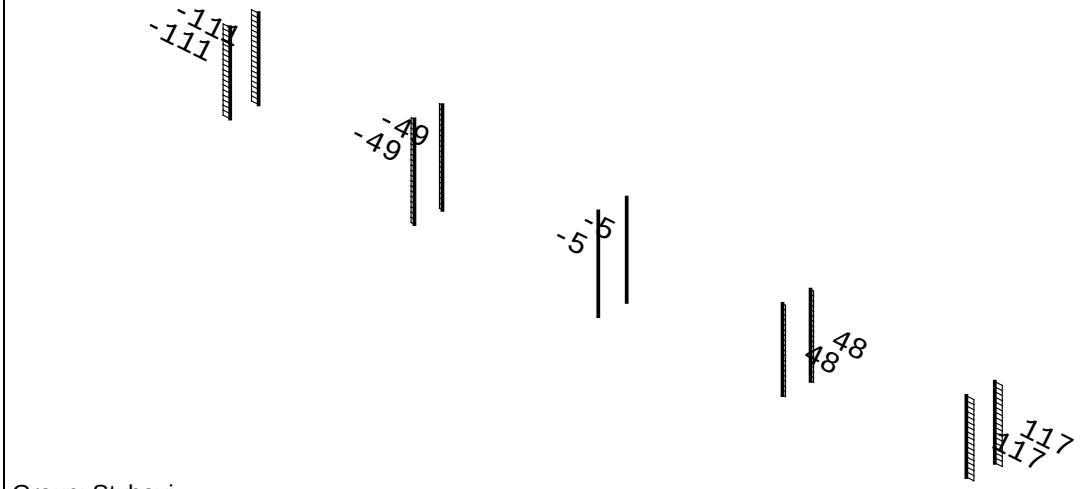
Group: Stubovi
Beam Results: max M1= 194 / min M1= -194 kNm

Load 4: Skupljanje



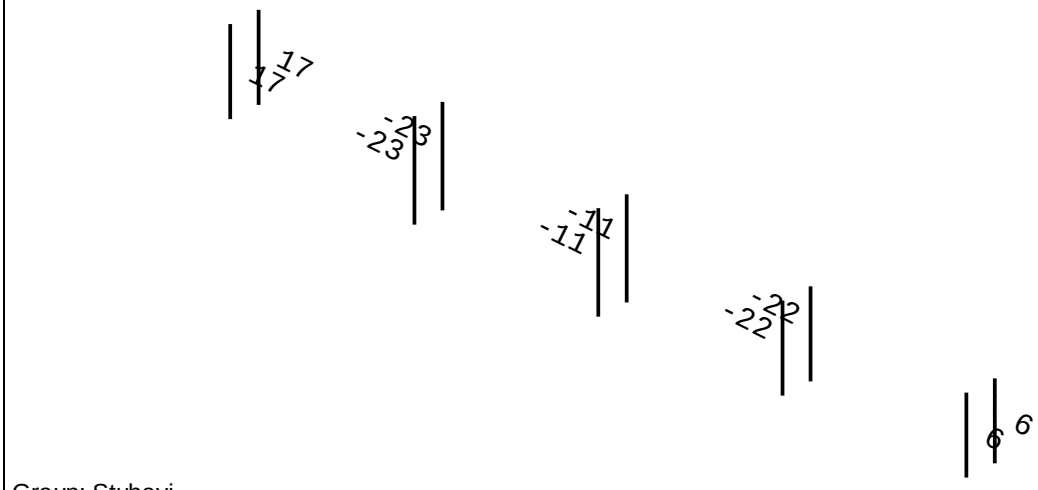
Group: Stubovi
Beam Results: max V3= 78 / min V3= -78 kN

Load 4: Skupljanje



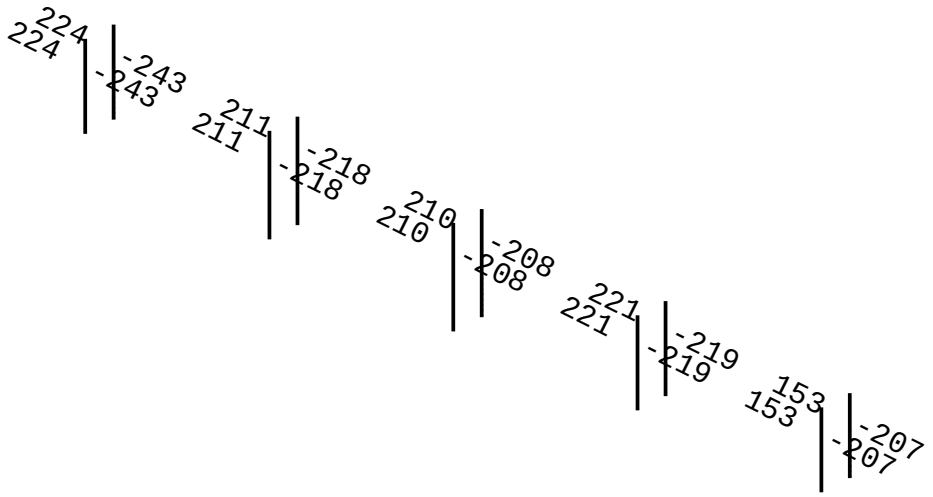
Group: Stubovi
Beam Results: max V2= 117 / min V2= -111 kN

Load 4: Skupljanje



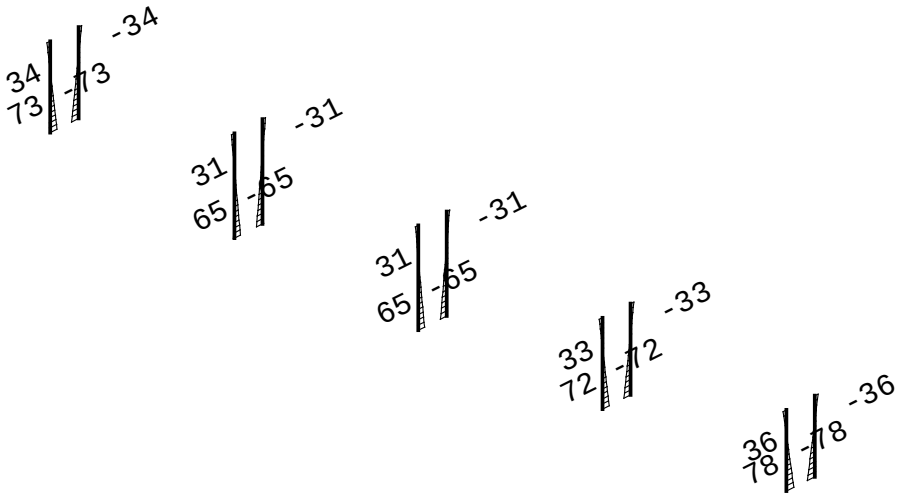
Group: Stubovi
Beam Results: max N1= 330 / min N1= -23 kN

Load 5: TS



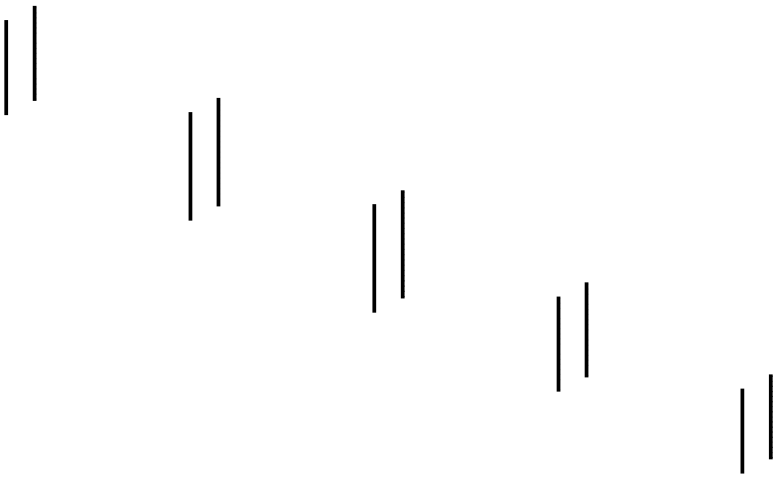
Group: Stubovi
Beam Results: max M3= 4191 / min M3= -2400 kNm

Load 5: TS



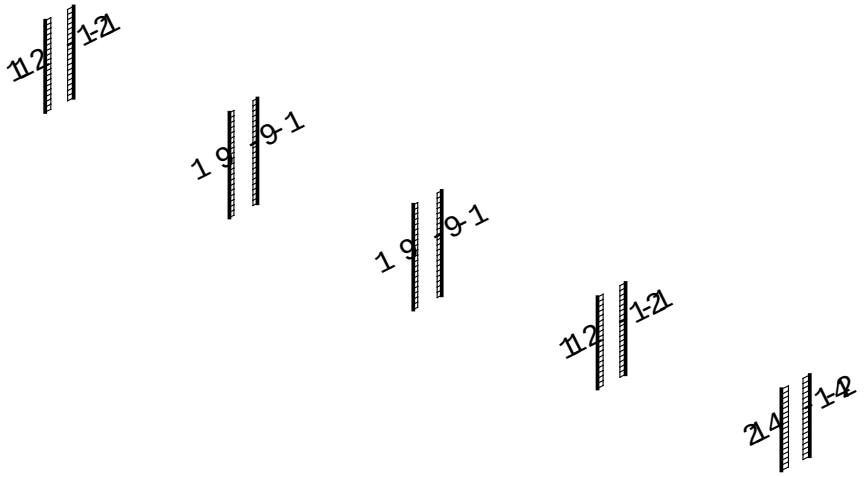
Group: Stubovi
Beam Results: max M2= 78 / min M2= -78 kNm

Load 5: TS



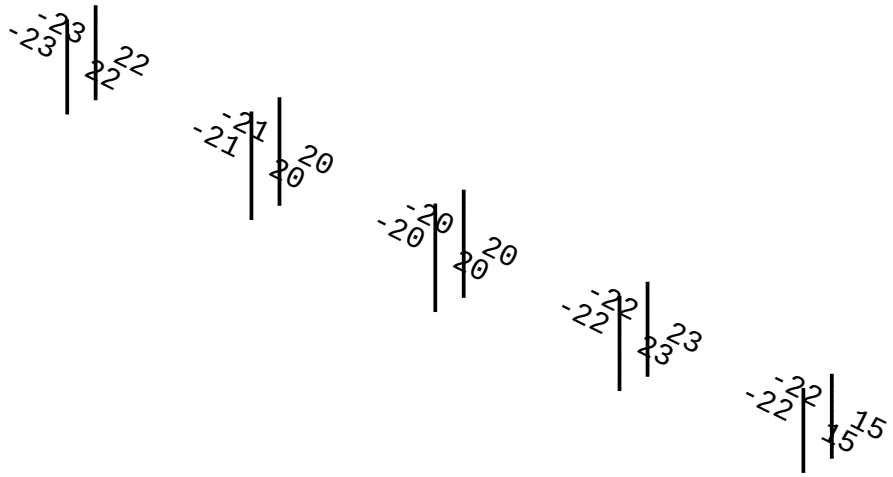
Group: Stubovi
Beam Results: max M1= 23 / min M1= -23 kNm

Load 5: TS



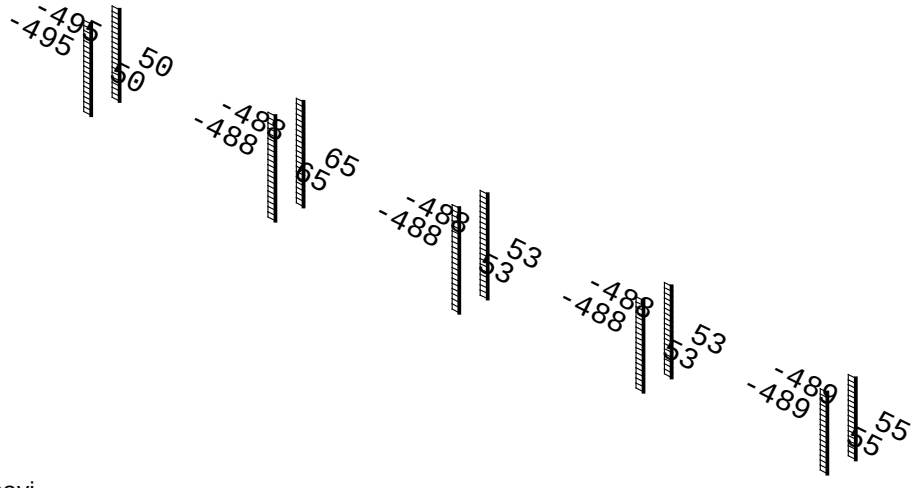
Group: Stubovi
Beam Results: max V3= 15 / min V3= -15 kN

Load 5: TS



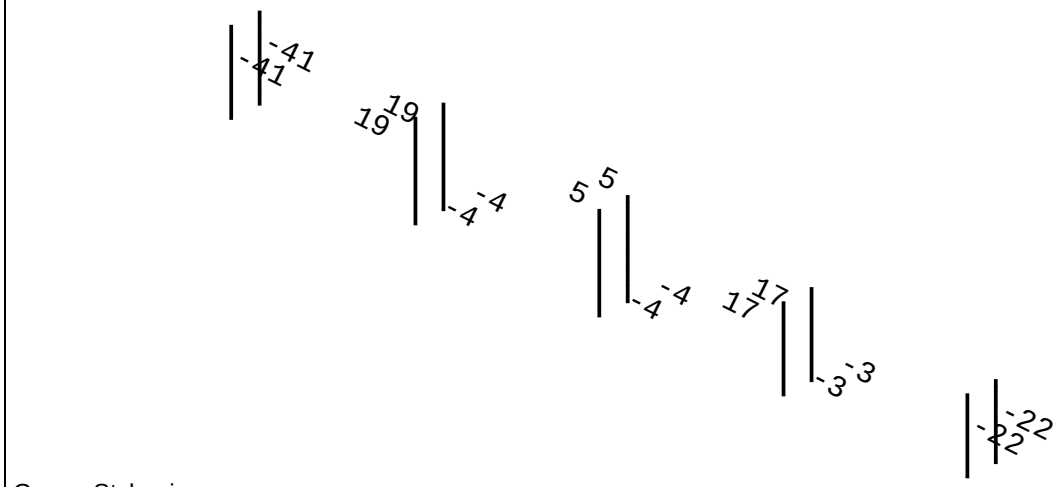
Group: Stubovi
Beam Results: max V2= 974 / min V2= -968 kN

Load 5: TS



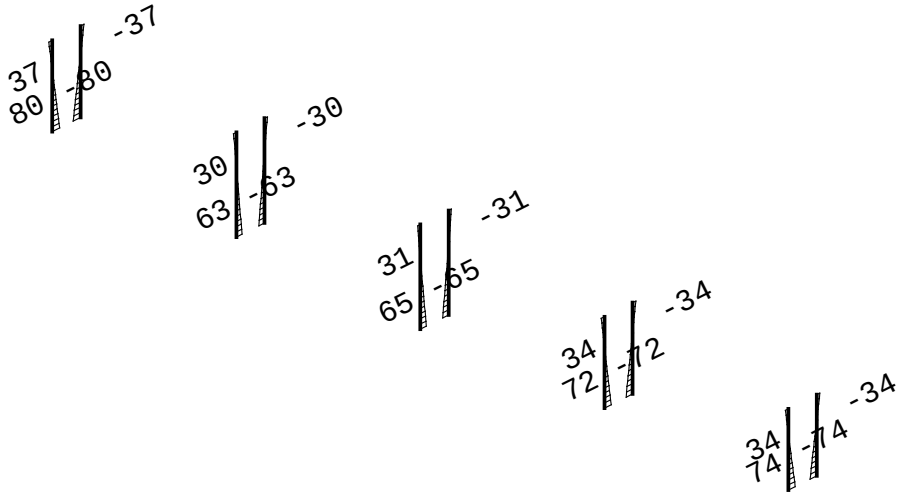
Group: Stubovi
Beam Results: max N1= 65 / min N1= -495 kN

Load 6: UDL



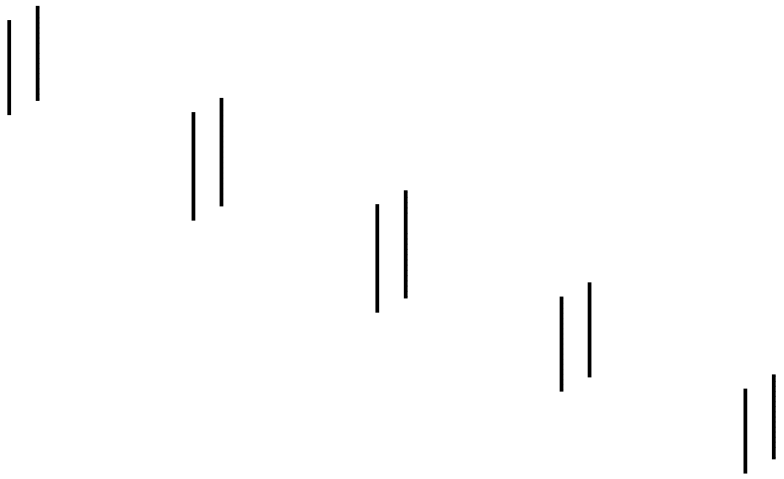
Group: Stubovi
Beam Results: max M3= 1683 / min M3= -2241 kNm

Load 6: UDL



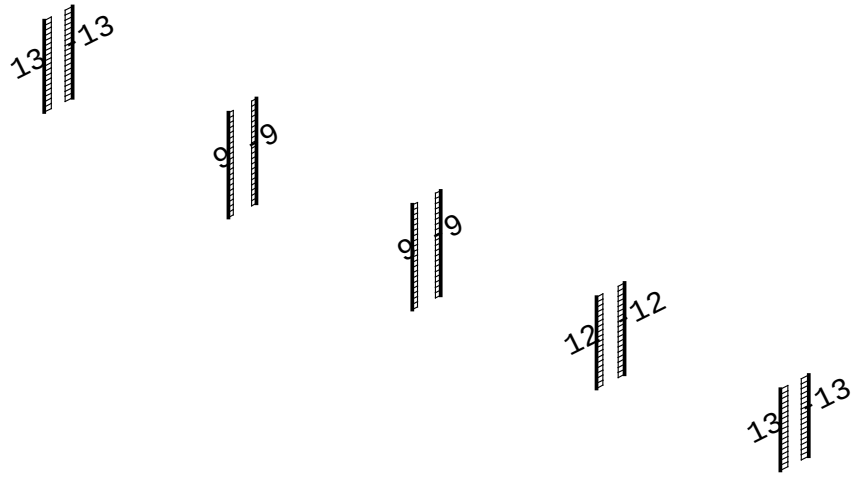
Group: Stubovi
Beam Results: max M2= 80 / min M2= -80 kNm

Load 6: UDL



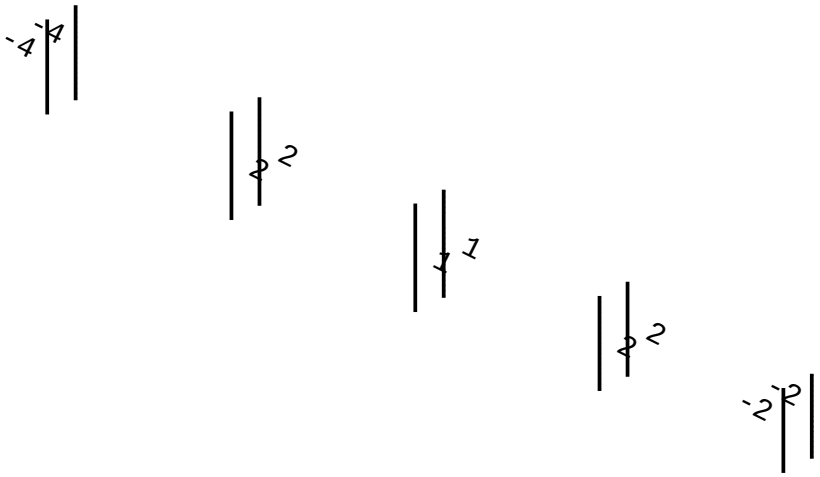
Group: Stubovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 6: UDL



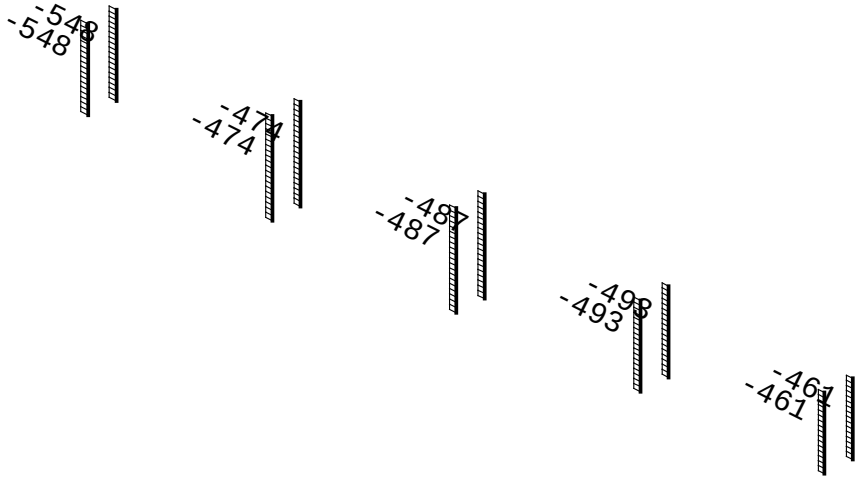
Group: Stubovi
Beam Results: max V3= 13 / min V3= -13 kN

Load 6: UDL



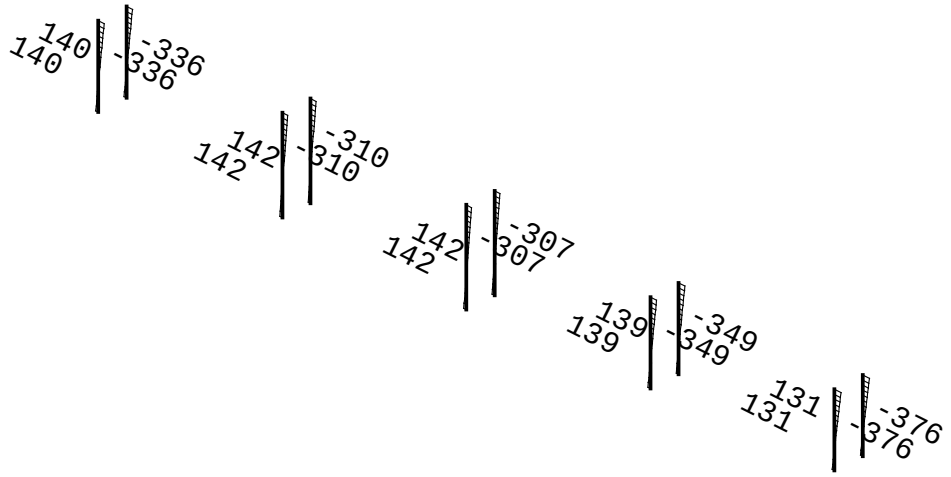
Group: Stubovi
Beam Results: max V2= 588 / min V2= -507 kN

Load 6: UDL



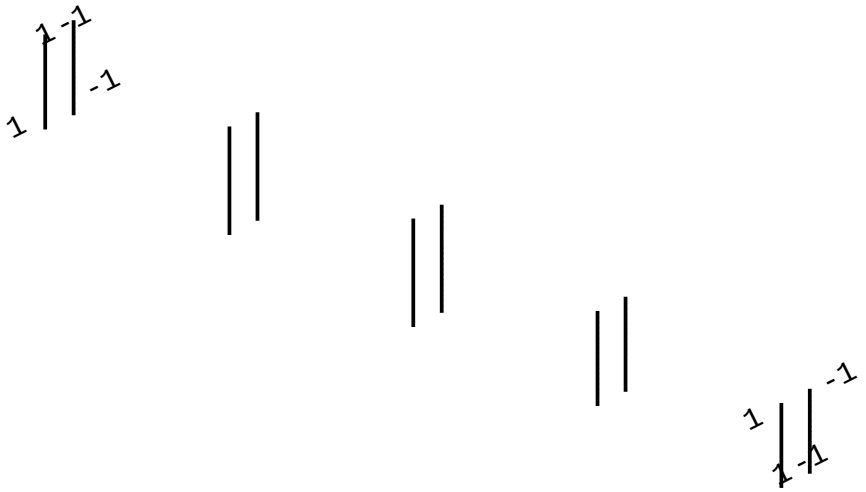
Group: Stubovi
Beam Results: max N1= 9 / min N1= -548 kN

Load 7: Kocenje



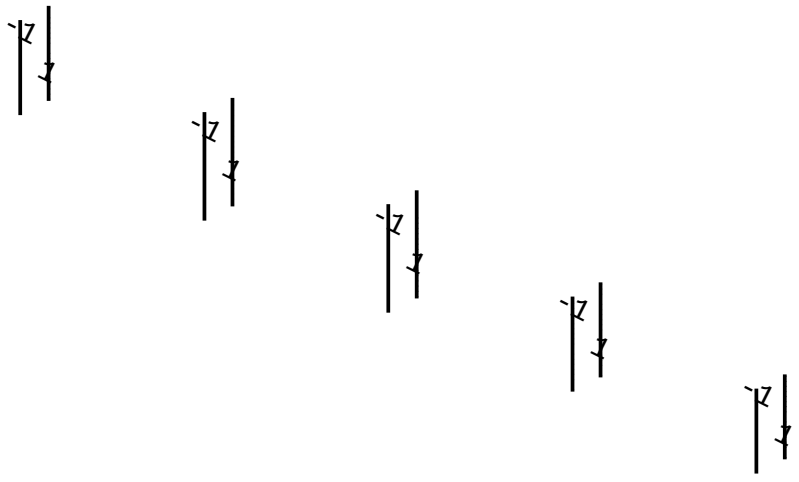
Group: Stubovi
Beam Results: max M3= 417 / min M3= -422 kNm

Load 7: Kocenje



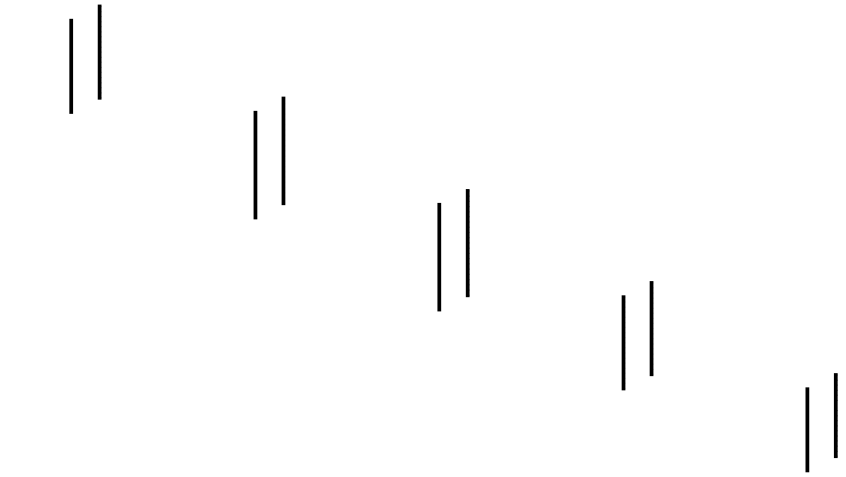
Group: Stubovi
Beam Results: max M2= 81 / min M2= -2 kNm

Load 7: Kocenje



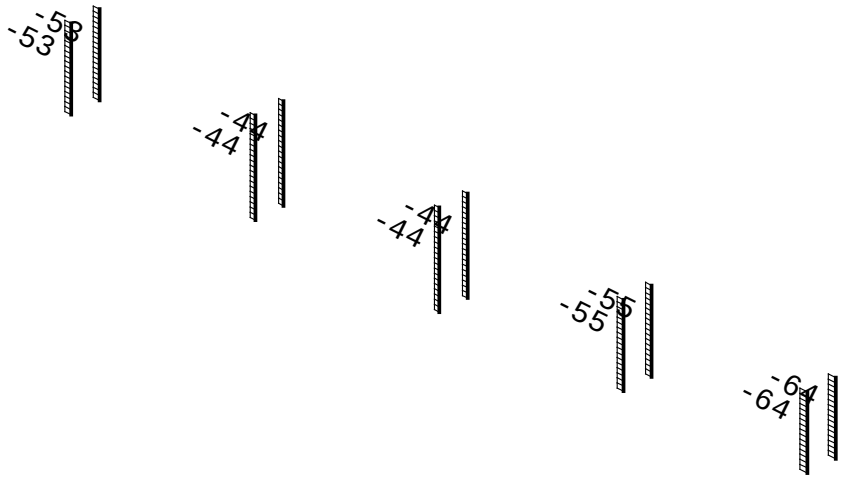
Group: Stubovi
Beam Results: max M1= 94 / min M1= -94 kNm

Load 7: Kocenje



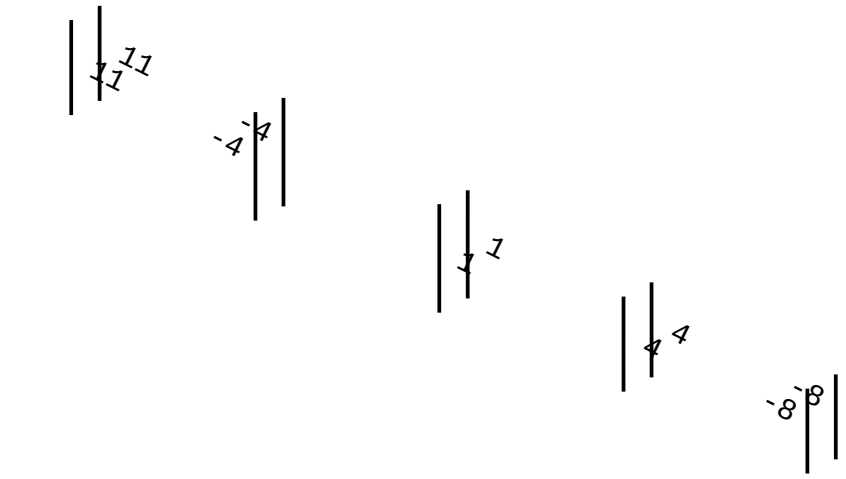
Group: Stubovi
Beam Results: max V3= 43 / min V3= -43 kN

Load 7: Kocenje



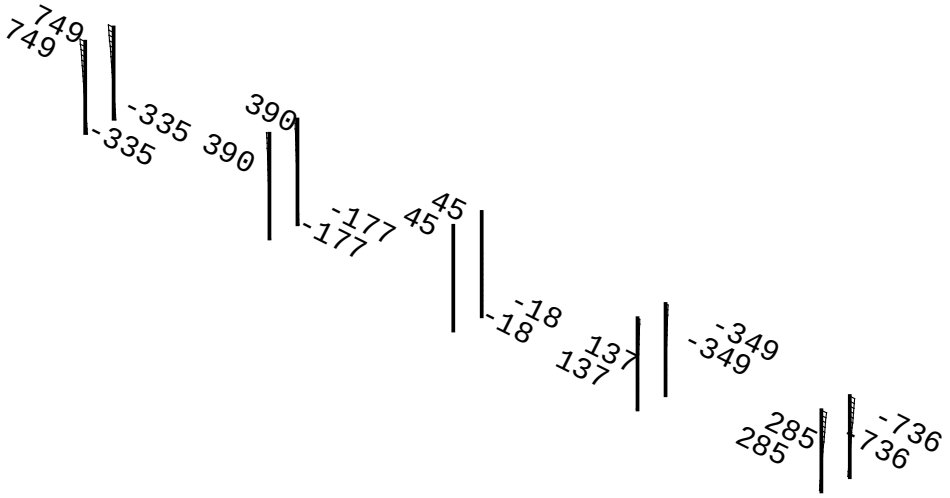
Group: Stubovi
Beam Results: max V2= 36 / min V2= -64 kN

Load 7: Kocenje



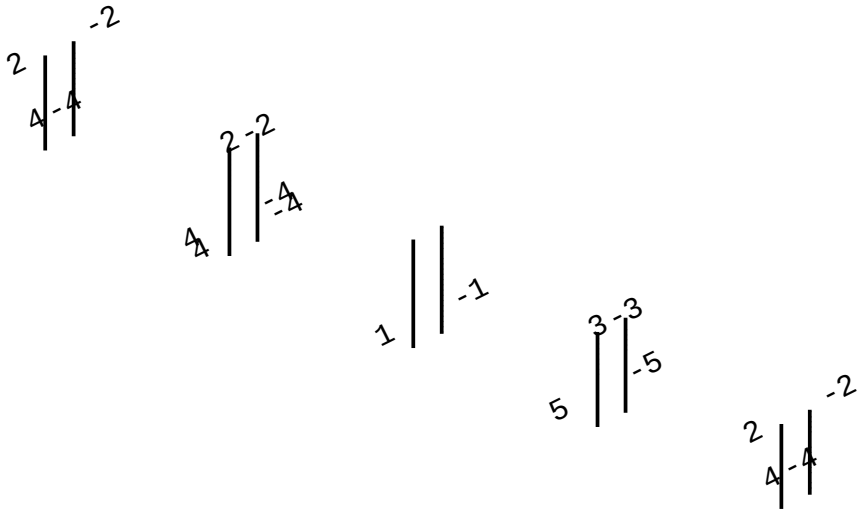
Group: Stubovi
Beam Results: max N1= 66 / min N1= -91 kN

Load 8: to+34



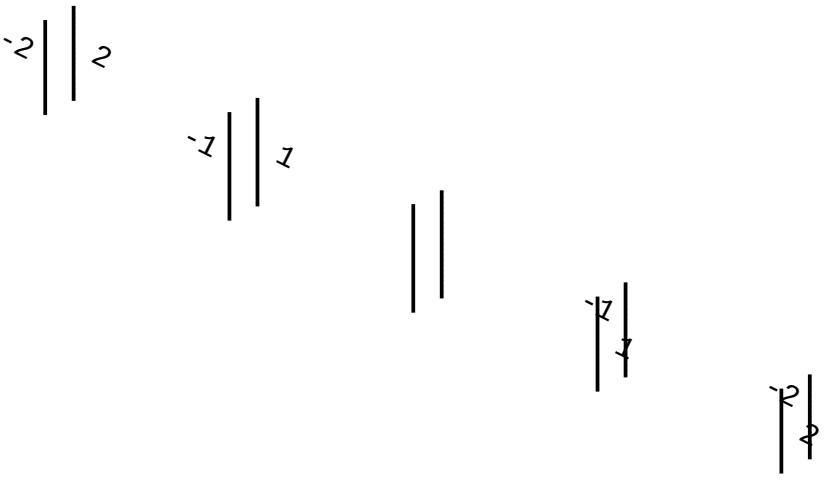
Group: Stubovi
Beam Results: max M3= 749 / min M3= -1090 kNm

Load 8: to+34



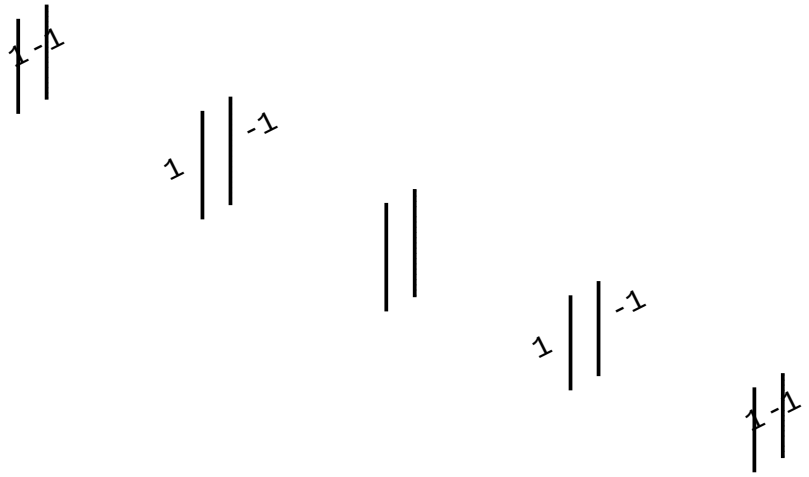
Group: Stubovi
Beam Results: max M2= 163 / min M2= -154 kNm

Load 8: to+34



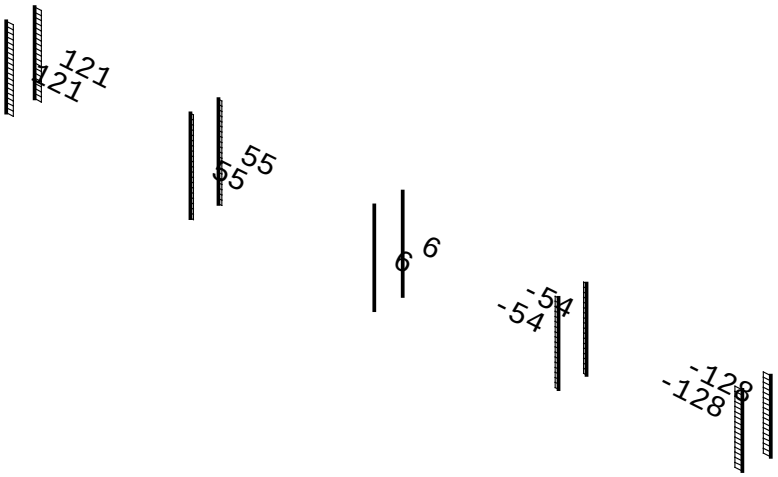
Group: Stubovi
Beam Results: max M1= 221 / min M1= -221 kNm

Load 8: to+34



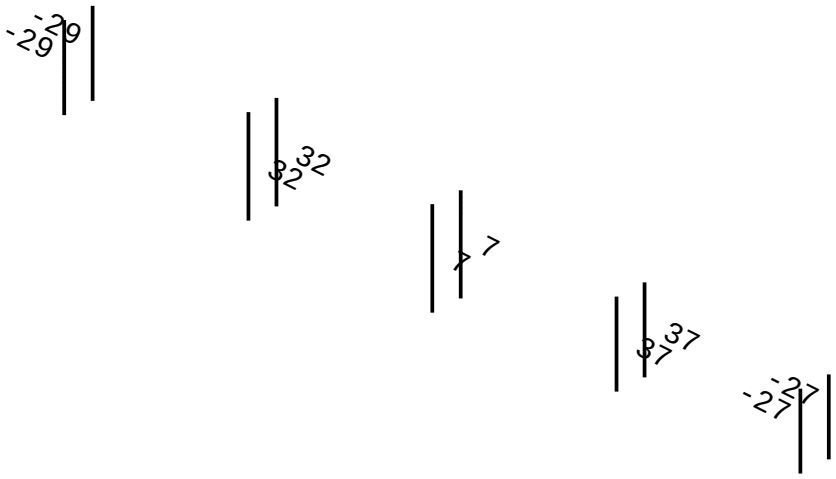
Group: Stubovi
Beam Results: max V3= 86 / min V3= -86 kN

Load 8: to+34



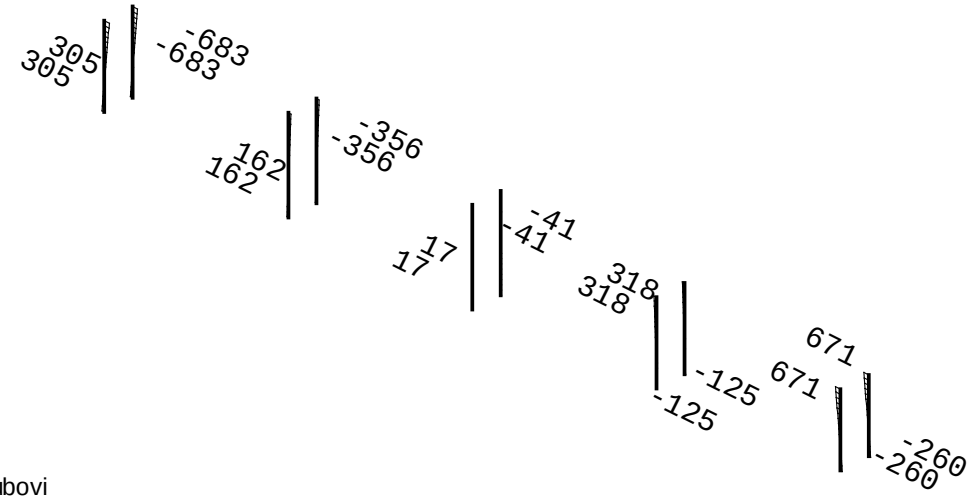
Group: Stubovi
Beam Results: max V2= 121 / min V2= -128 kN

Load 8: to+34



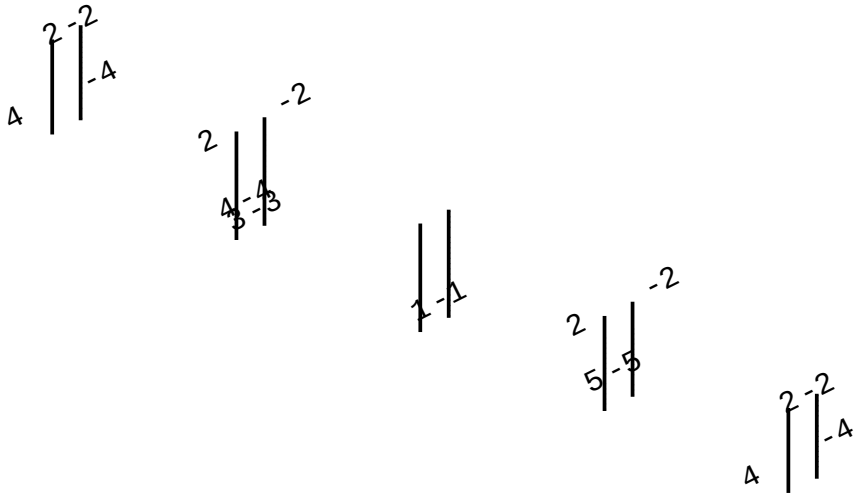
Group: Stubovi
Beam Results: max N1= 37 / min N1= -365 kN

Load 9: to-31



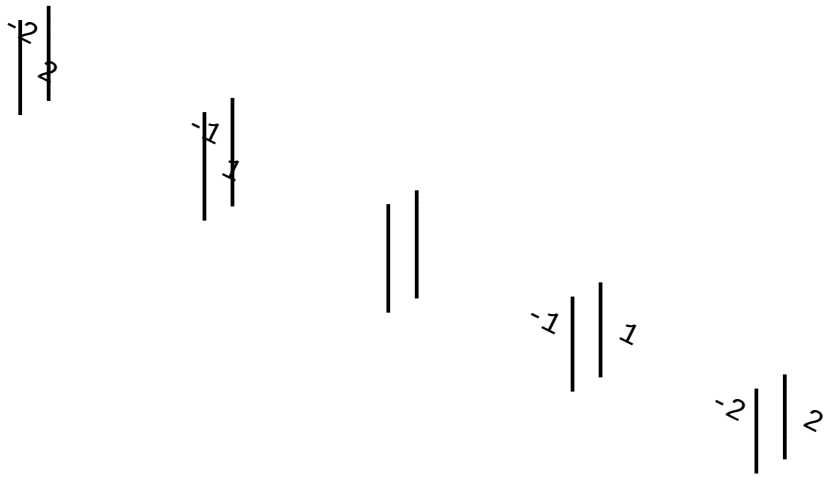
Group: Stubovi
Beam Results: max M3= 994 / min M3= -683 kNm

Load 9: to-31



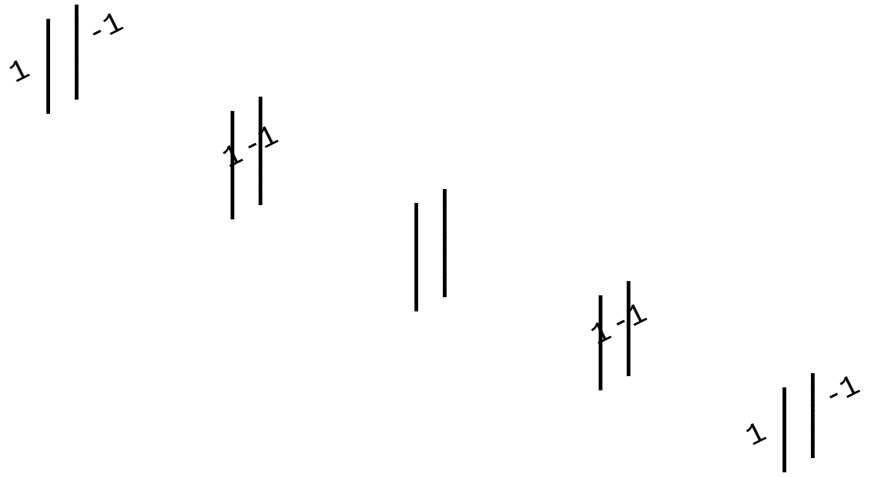
Group: Stubovi
Beam Results: max M2= 140 / min M2= -148 kNm

Load 9: to-31



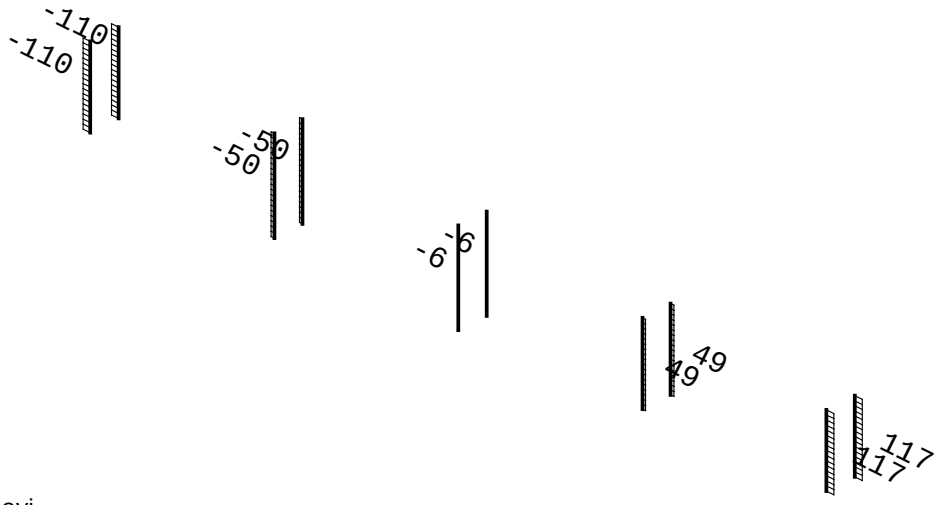
Group: Stubovi
Beam Results: max M1= 201 / min M1= -201 kNm

Load 9: to-31



Group: Stubovi
Beam Results: max V3= 78 / min V3= -78 kN

Load 9: to-31

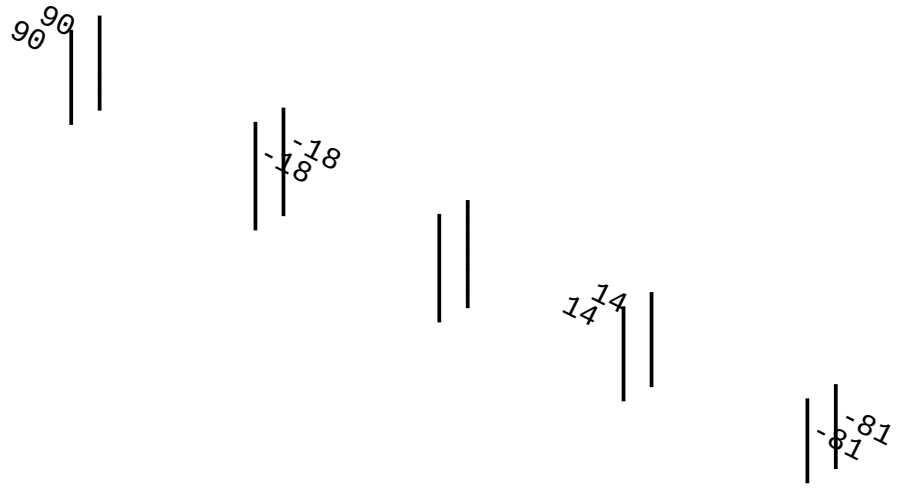


Group: Stubovi
Beam Results: max V2= 117 / min V2= -110 kN

Load 9: to-31

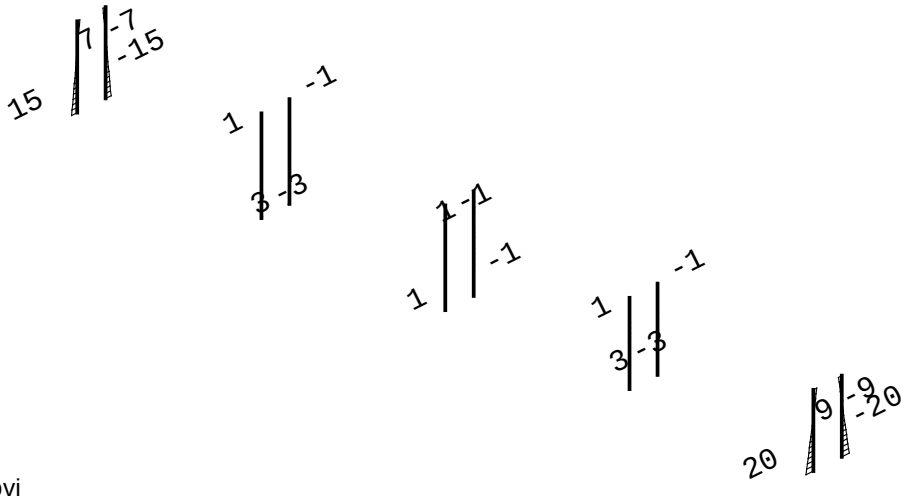
Group: Stubovi
Beam Results: max N1= 333 / min N1= -34 kN

Load 10: dt+12.3



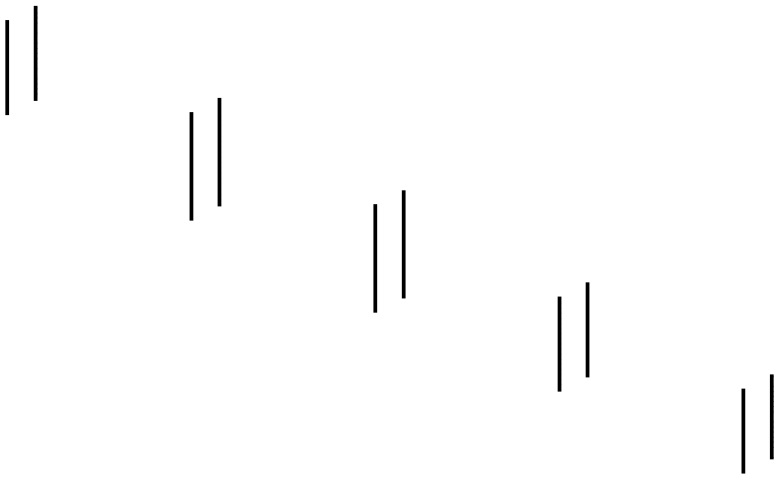
Group: Stubovi
Beam Results: max M3= 3644 / min M3= -140 kNm

Load 10: dt+12.3



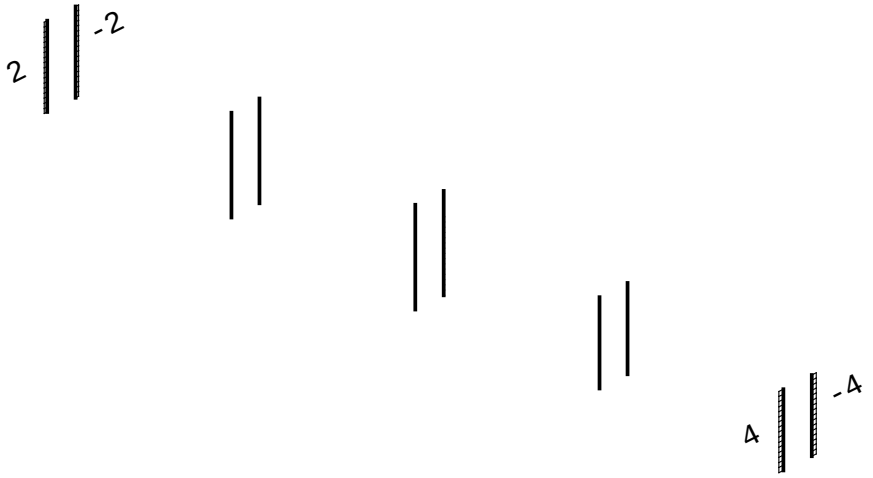
Group: Stubovi
Beam Results: max M2= 20 / min M2= -20 kNm

Load 10: dt+12.3



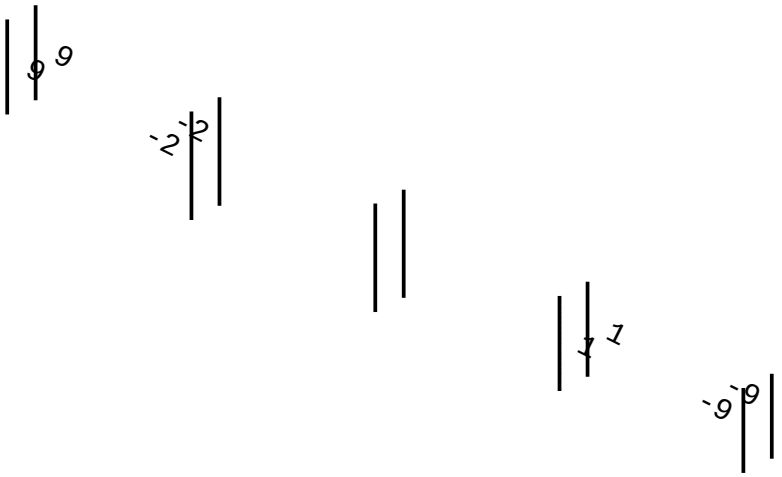
Group: Stubovi
Beam Results: max M1= 7 / min M1= -7 kNm

Load 10: dt+12.3



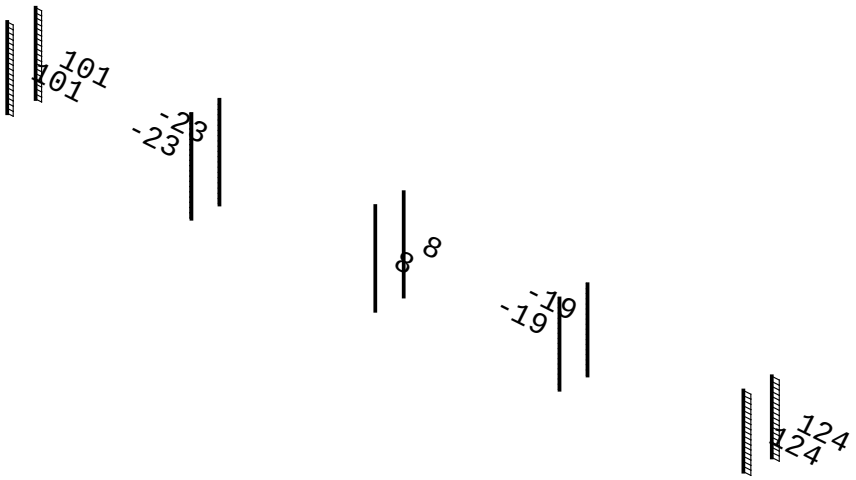
Group: Stubovi
Beam Results: max V3= 6 / min V3= -6 kN

Load 10: dt+12.3



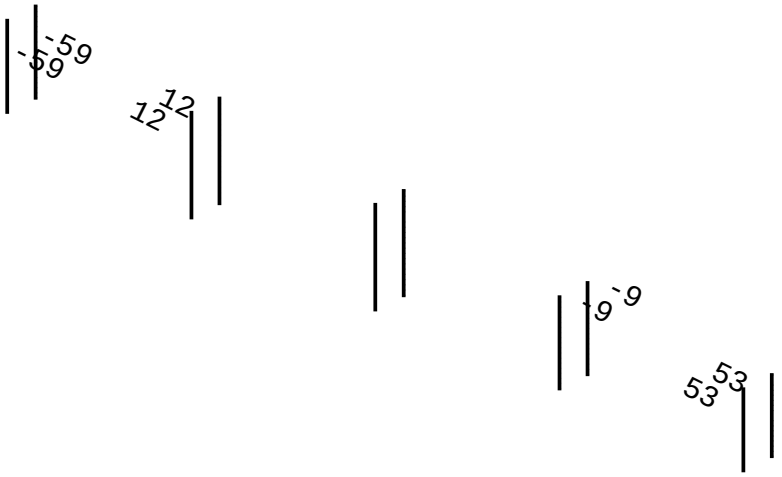
Group: Stubovi
Beam Results: max V2= 219 / min V2= -165 kN

Load 10: dt+12.3



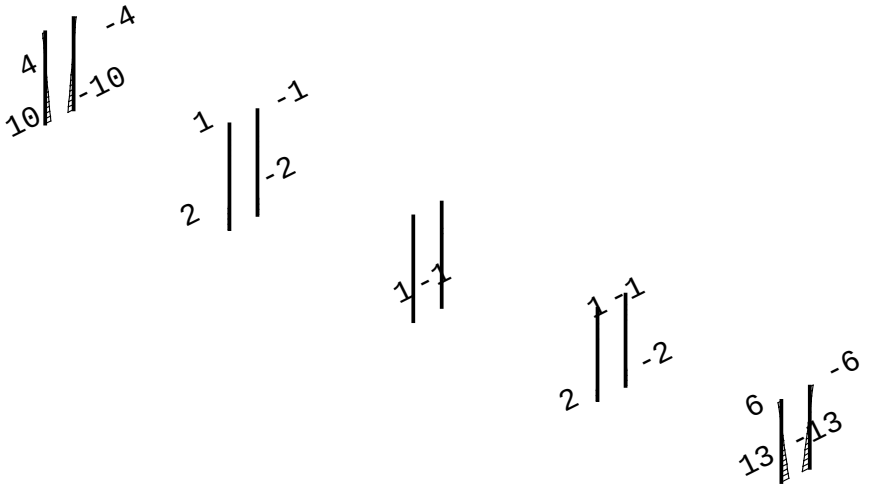
Group: Stubovi
Beam Results: max N1= 124 / min N1= -23 kN

Load 11: dt-8



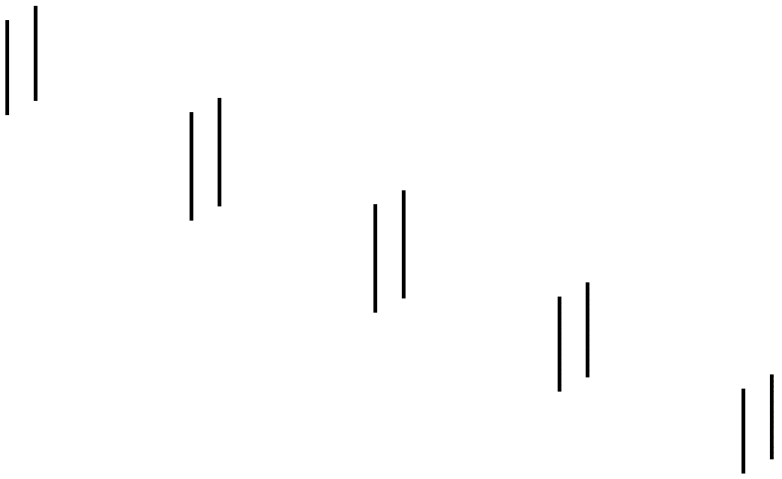
Group: Stubovi
Beam Results: max M3= 91 / min M3= -2370 kNm

Load 11: dt-8



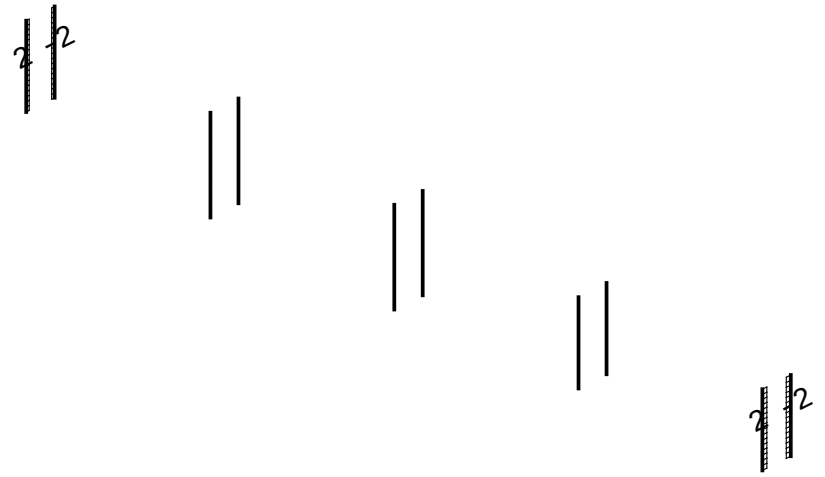
Group: Stubovi
Beam Results: max M2= 13 / min M2= -13 kNm

Load 11: dt-8



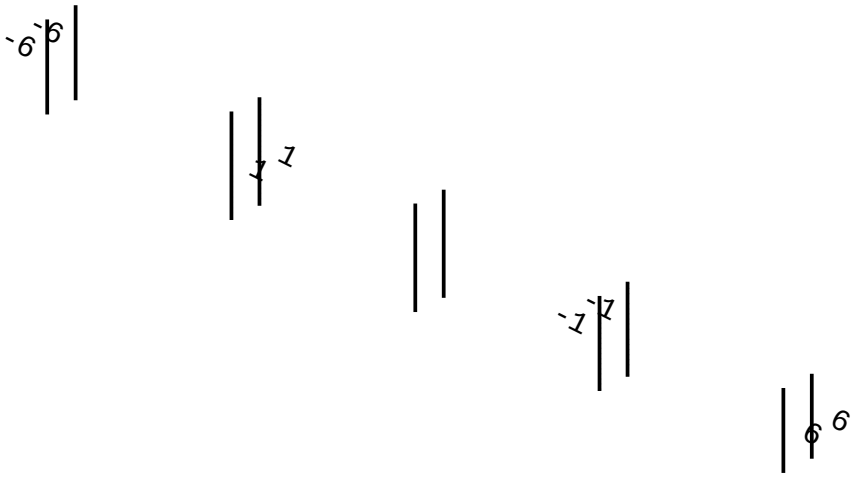
Group: Stubovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 11: dt-8



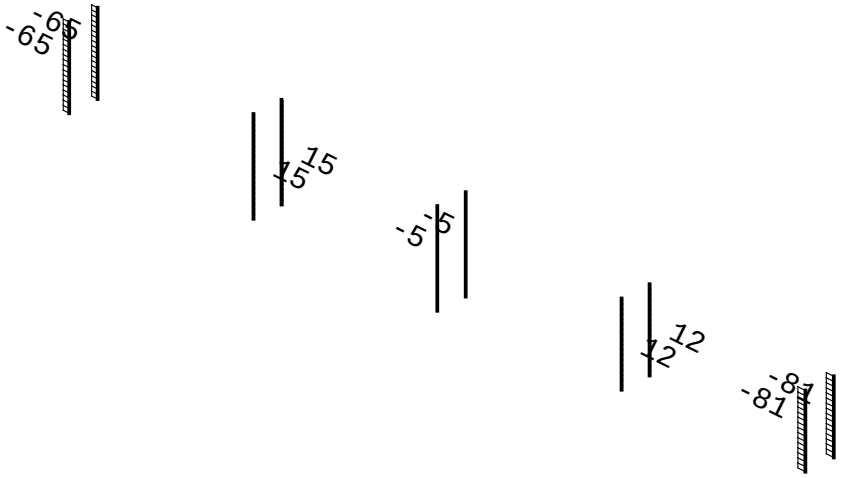
Group: Stubovi
Beam Results: max V3= 4 / min V3= -4 kN

Load 11: dt-8



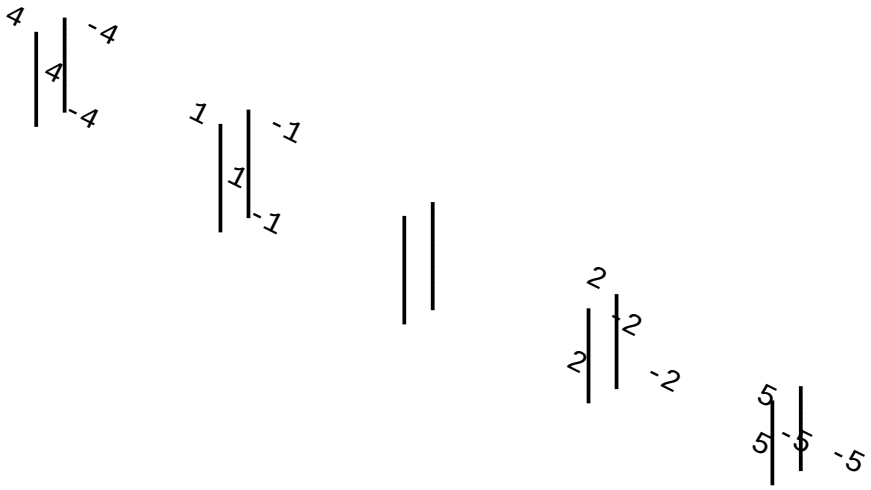
Group: Stubovi
Beam Results: max V2= 107 / min V2= -142 kN

Load 11: dt-8



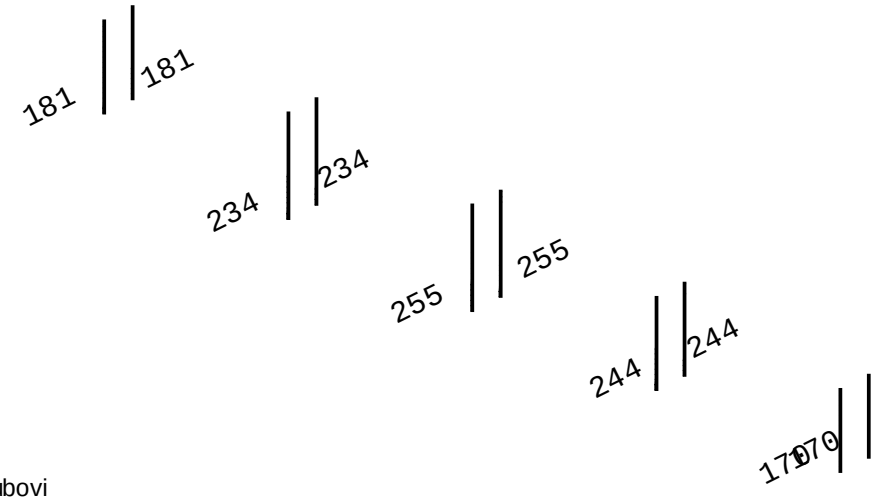
Group: Stubovi
Beam Results: max N1= 15 / min N1= -81 kN

Load 12: Vetar



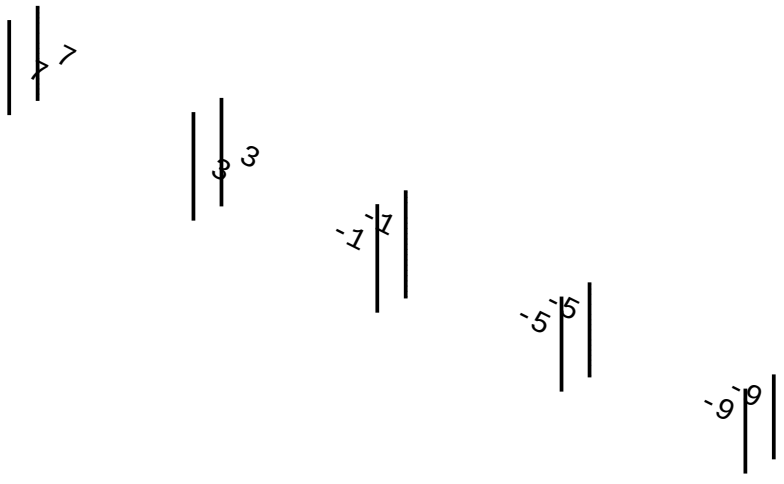
Group: Stubovi
Beam Results: max M3= 217 / min M3= -217 kNm

Load 12: Vetar



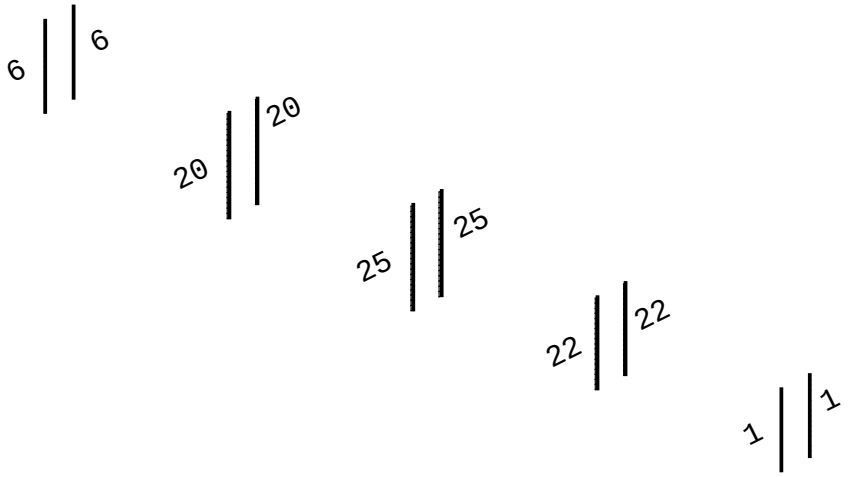
Group: Stubovi
Beam Results: max M2= 255 / min M2= -1400 kNm

Load 12: Vetar



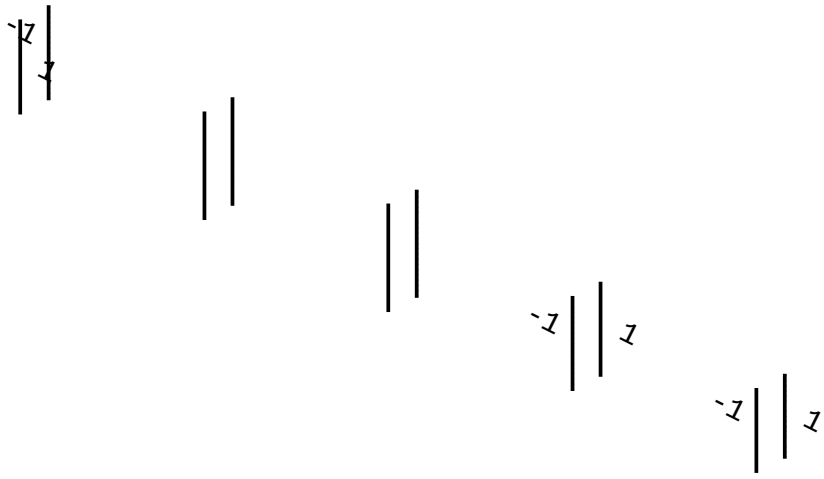
Group: Stubovi
Beam Results: max M1= 227 / min M1= -128 kNm

Load 12: Vetar



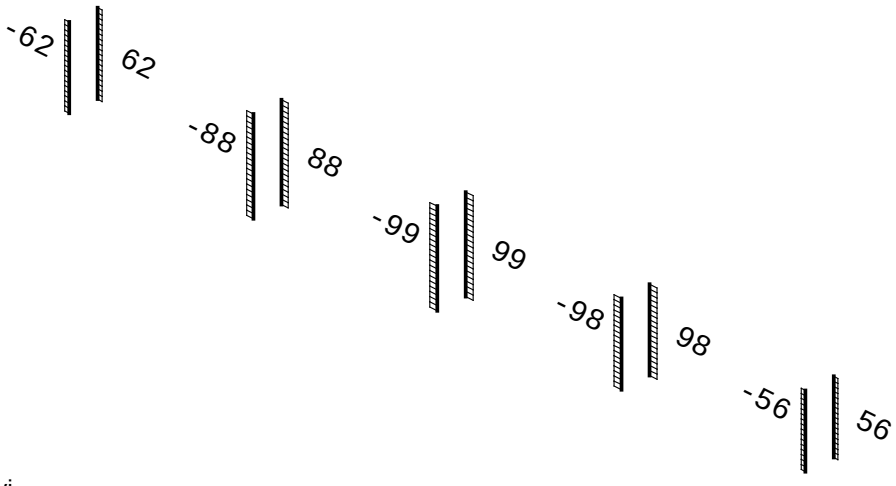
Group: Stubovi
Beam Results: max V3= 73 / min V3= -75 kN

Load 12: Vetar



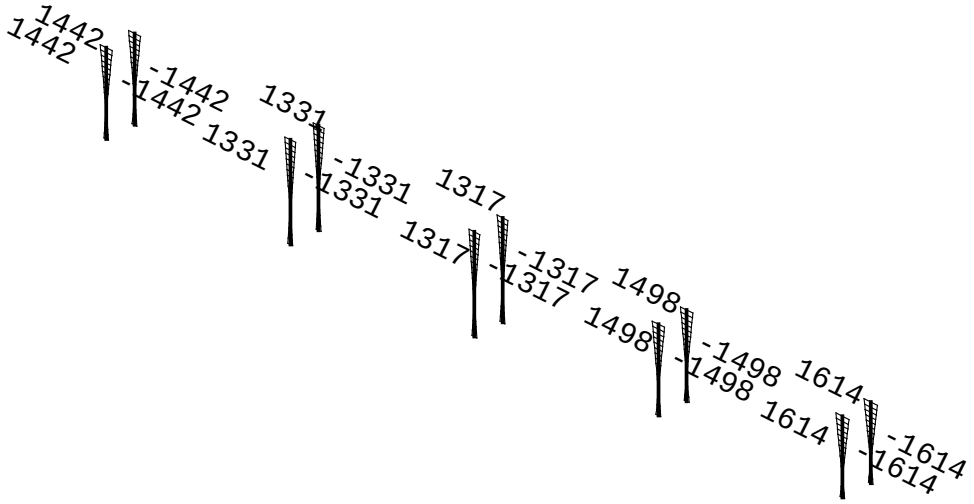
Group: Stubovi
Beam Results: max V2= 143 / min V2= -2 kN

Load 12: Vetar



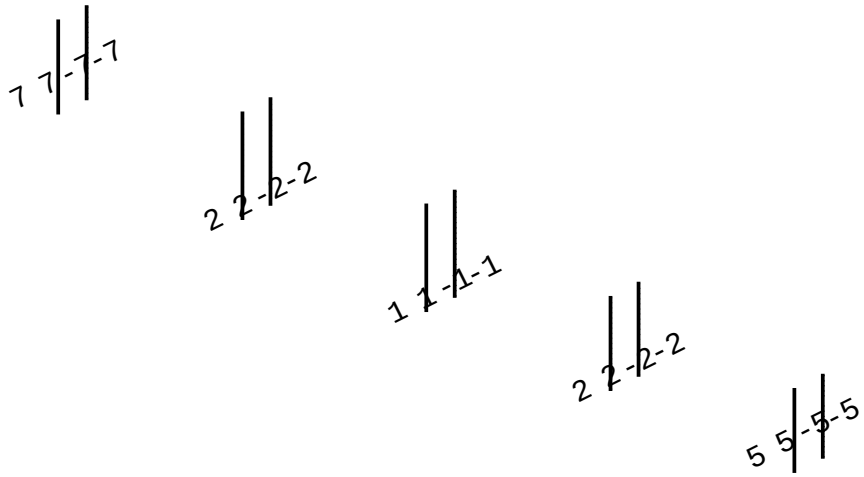
Group: Stubovi
Beam Results: max N1= 99 / min N1= -99 kN

Load 13: Sx



Group: Stubovi
Beam Results: max M3= 1811 / min M3= -1811 kNm

Load 13: Sx

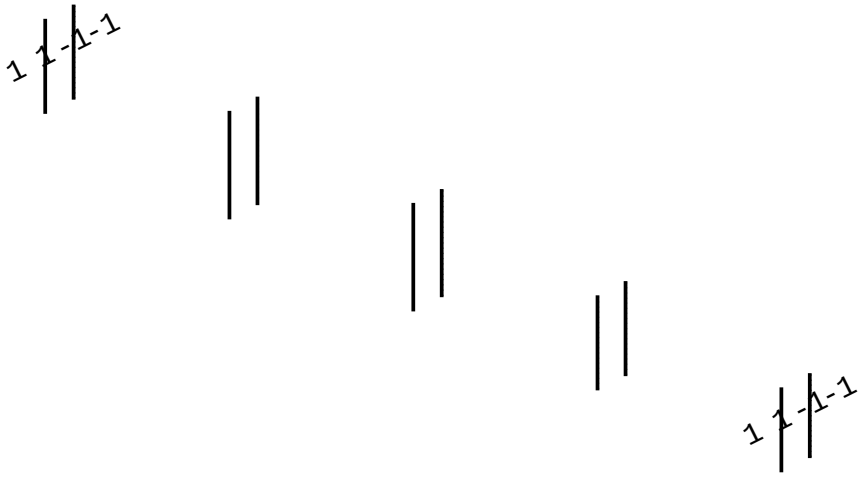


Group: Stubovi
Beam Results: max M2= 353 / min M2= -353 kNm

Load 13: Sx

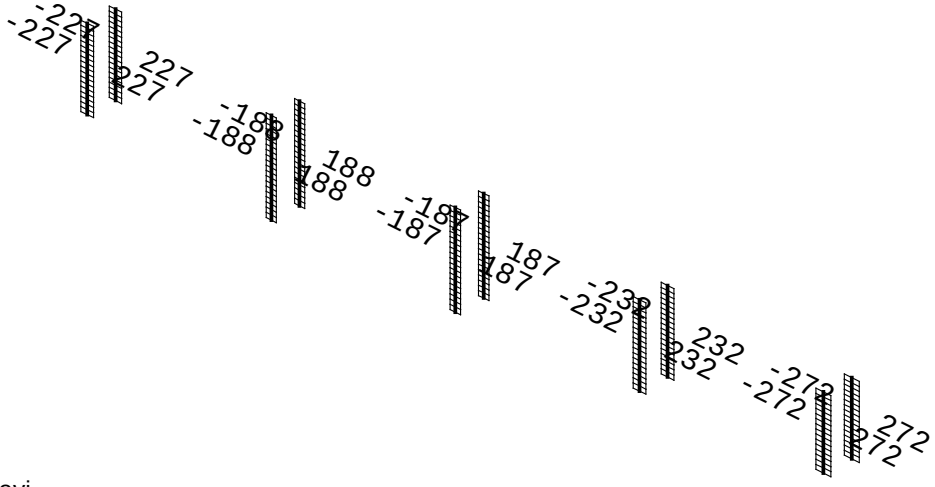
Group: Stubovi
Beam Results: max M1= 396 / min M1= -396 kNm

Load 13: Sx



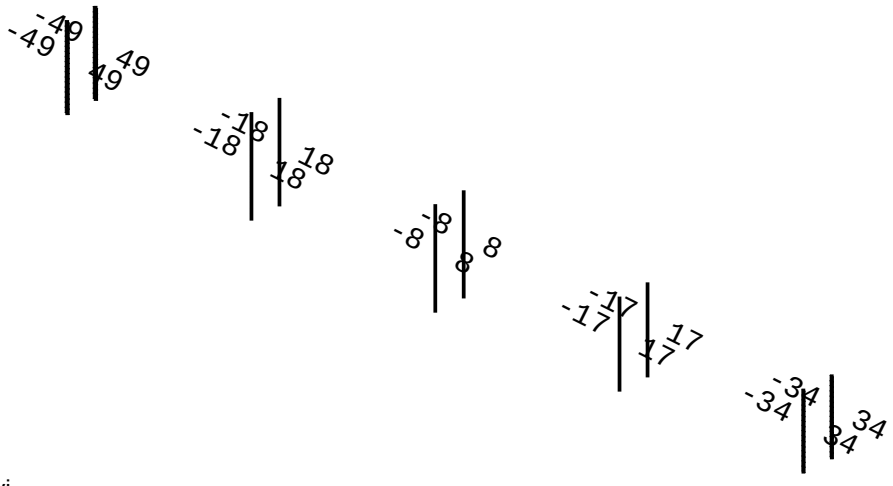
Group: Stubovi
Beam Results: max V3= 186 / min V3= -186 kN

Load 13: Sx



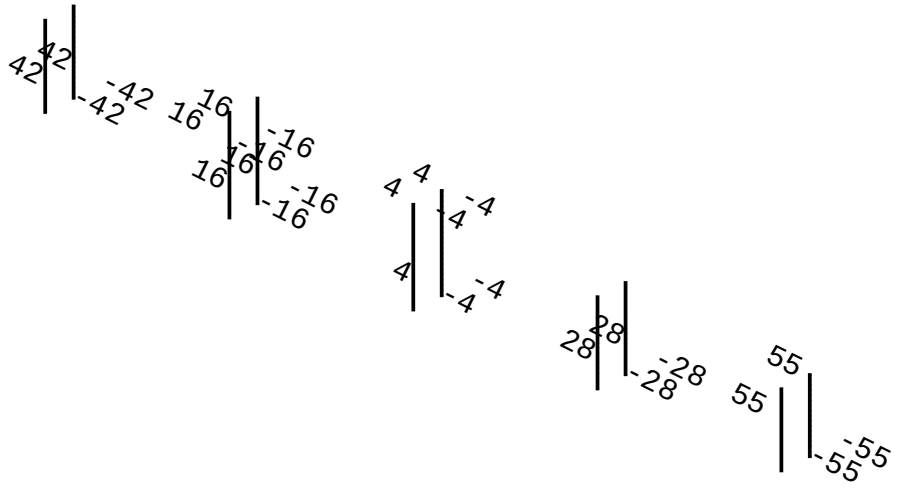
Group: Stubovi
Beam Results: max V2= 272 / min V2= -272 kN

Load 13: Sx



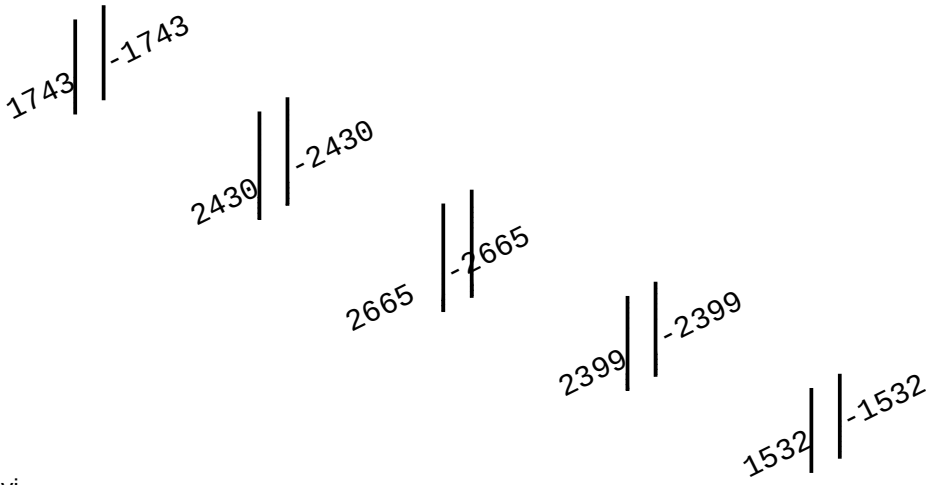
Group: Stubovi
Beam Results: max N1= 184 / min N1= -184 kN

Load 14: Sy



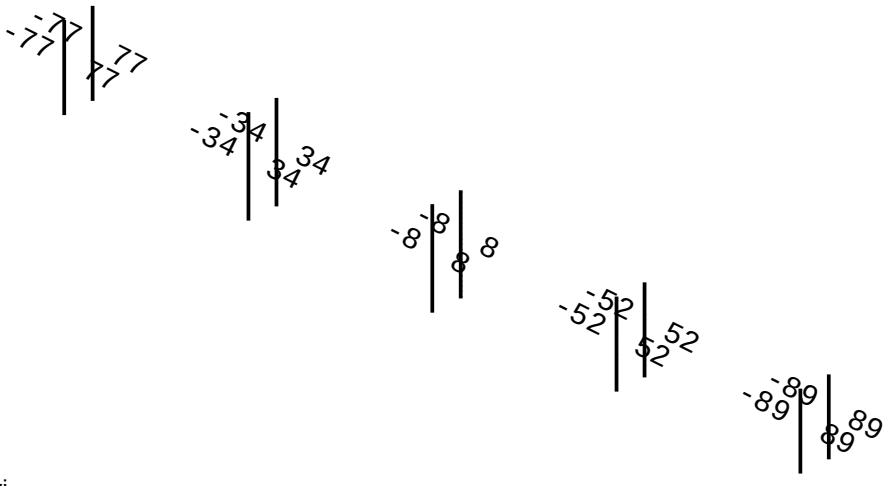
Group: Stubovi
Beam Results: max M3= 2410 / min M3= -2410 kNm

Load 14: Sy



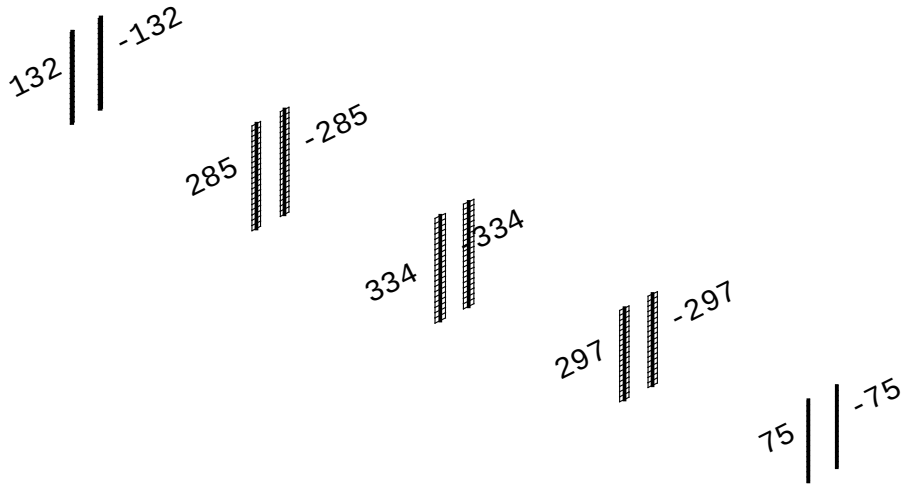
Group: Stubovi
Beam Results: max M2= 16706 / min M2= -16706 kNm

Load 14: Sy



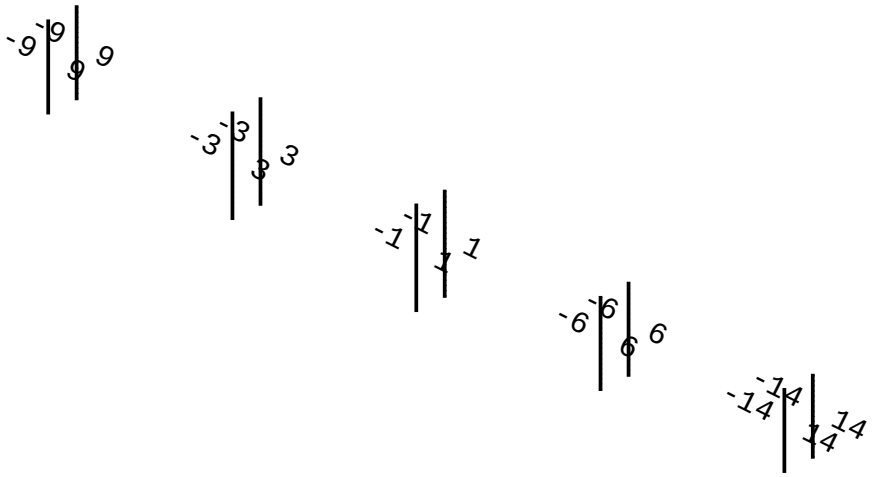
Group: Stubovi
Beam Results: max M1= 1883 / min M1= -1883 kNm

Load 14: Sy



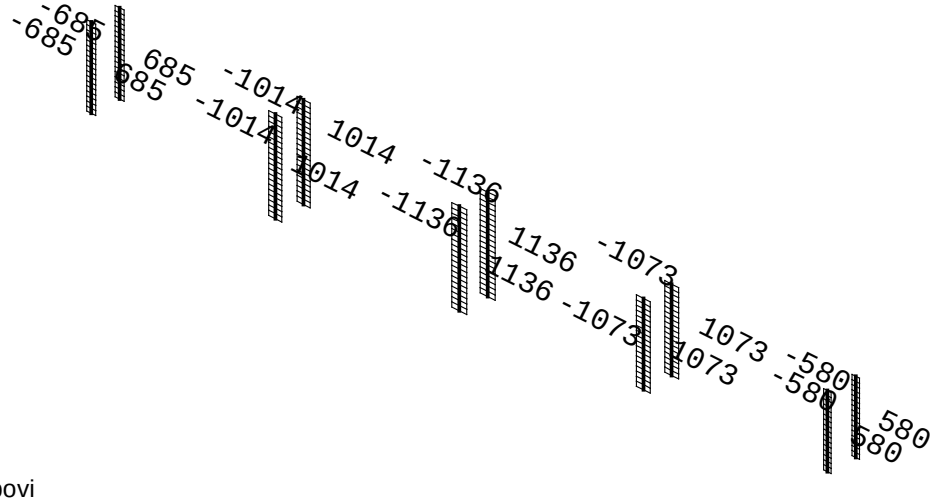
Group: Stubovi
Beam Results: max V3= 480 / min V3= -480 kN

Load 14: Sy



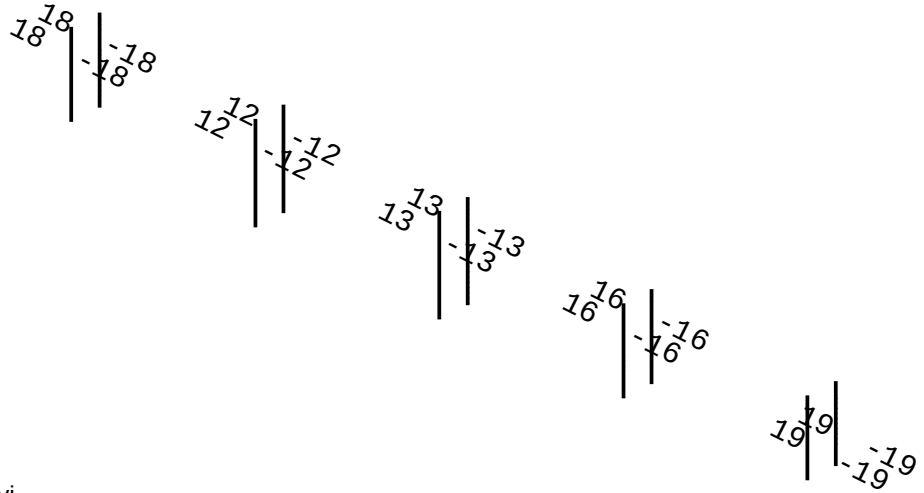
Group: Stubovi
Beam Results: max V2= 1652 / min V2= -1652 kN

Load 14: Sy



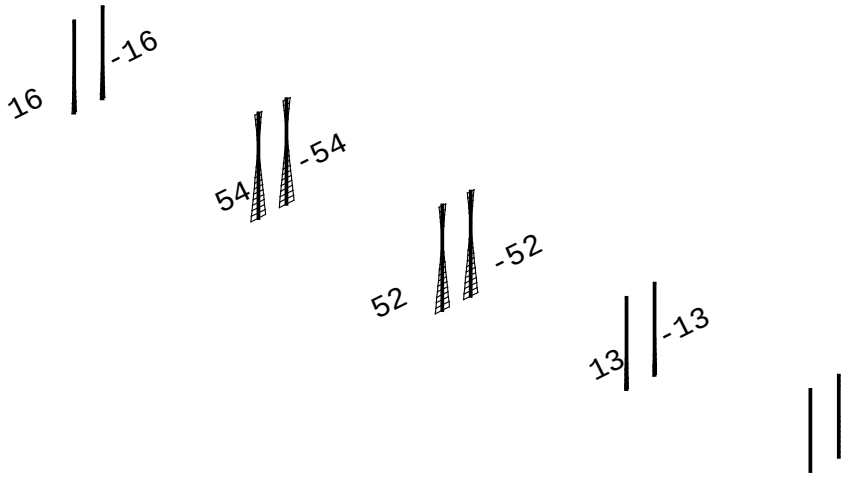
Group: Stubovi
Beam Results: max N1= 1136 / min N1= -1136 kN

Load 15: Sz



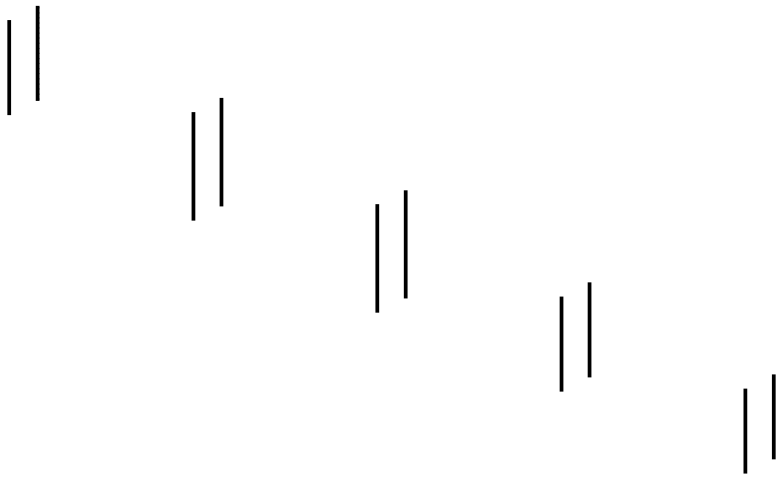
Group: Stubovi
Beam Results: max M3= 456 / min M3= -456 kNm

Load 15: Sz



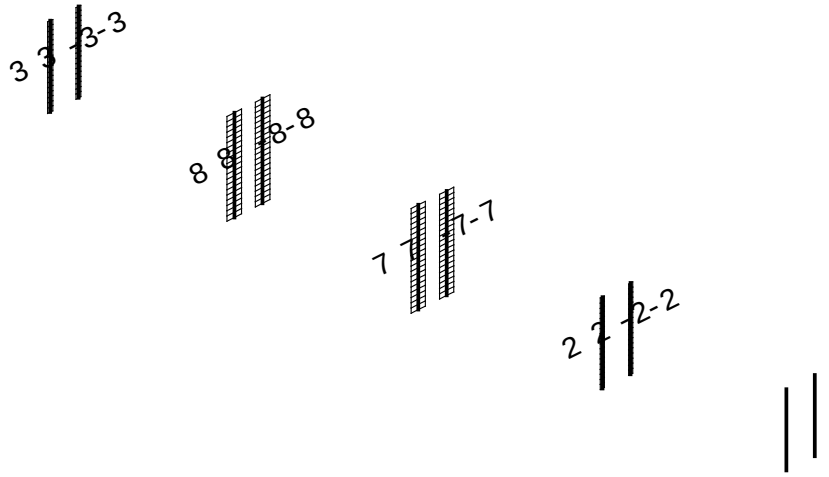
Group: Stubovi
Beam Results: max M2= 54 / min M2= -54 kNm

Load 15: Sz



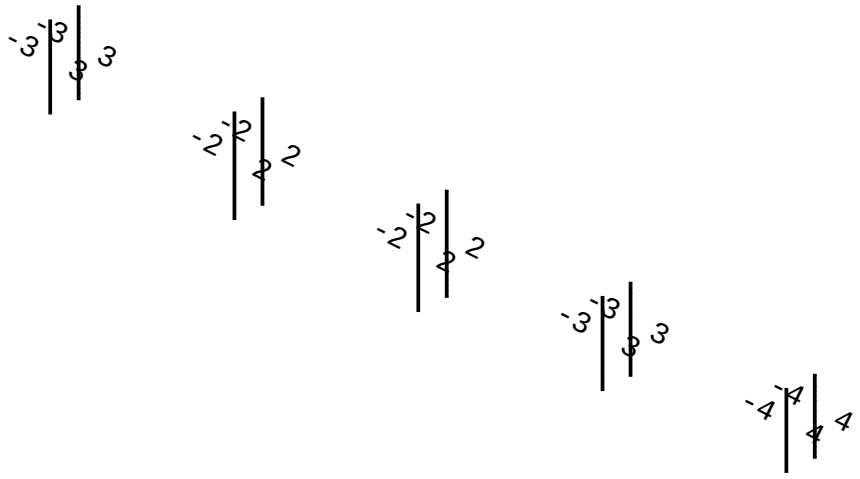
Group: Stubovi
Beam Results: max M1= 12 / min M1= -12 kNm

Load 15: Sz



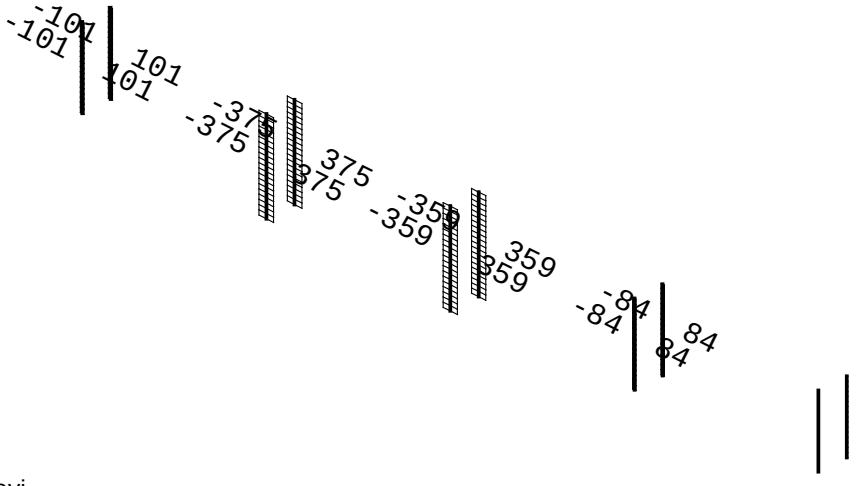
Group: Stubovi
Beam Results: max V3= 8 / min V3= -8 kN

Load 15: Sz



Group: Stubovi
Beam Results: max V2= 257 / min V2= -257 kN

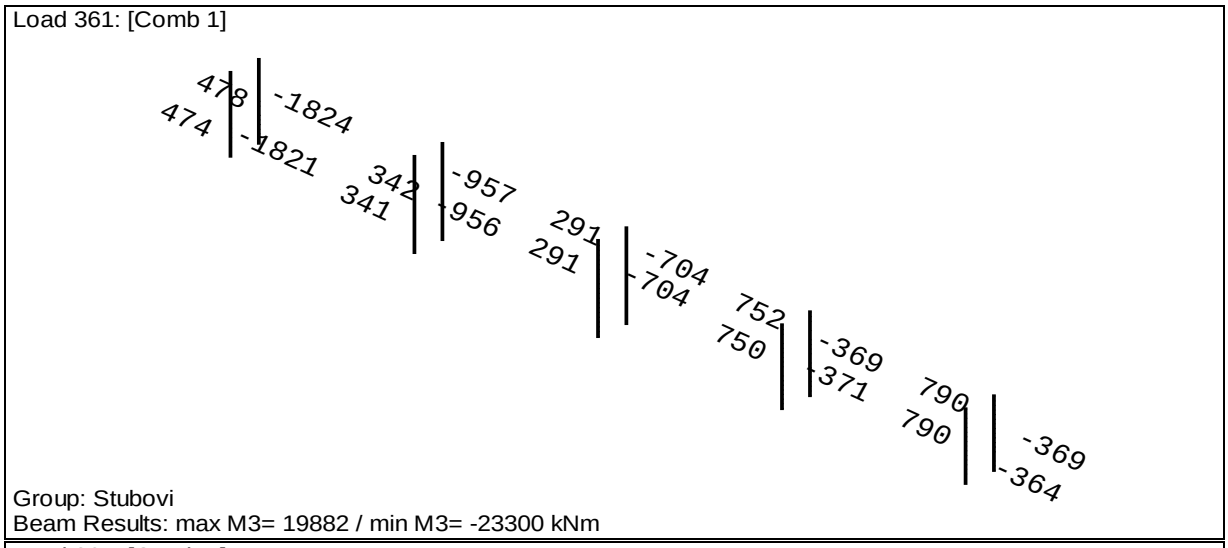
Load 15: Sz

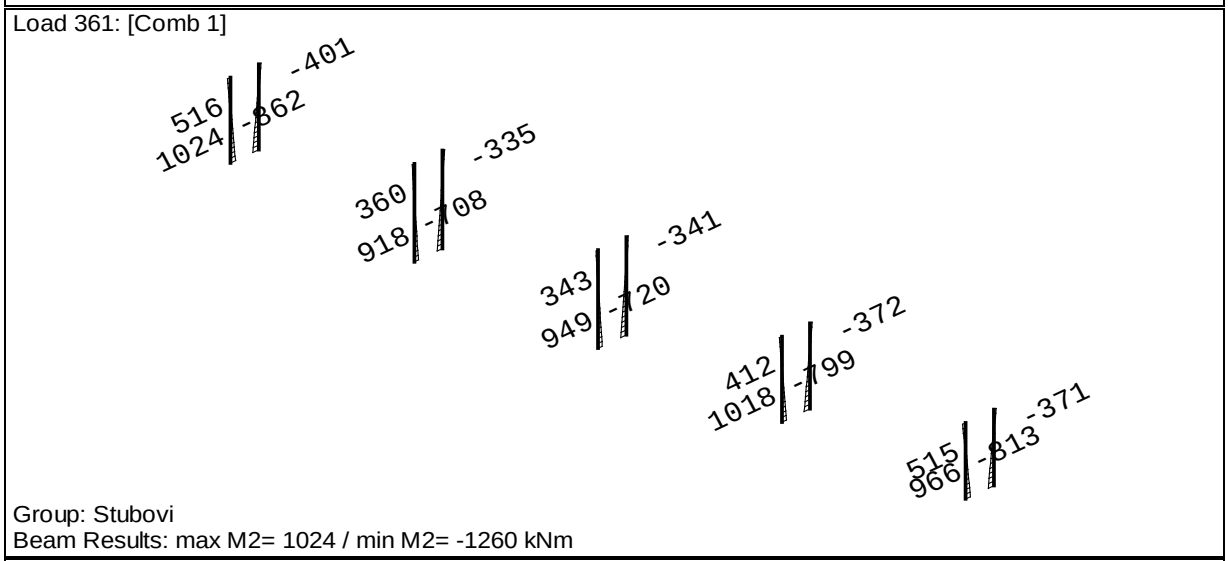


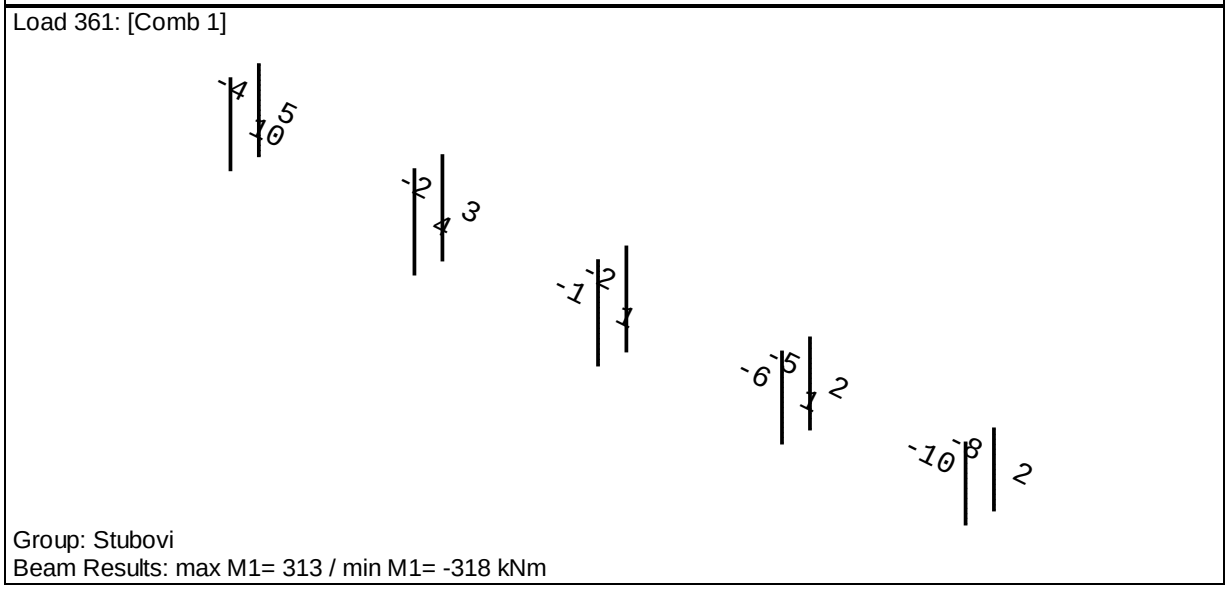
Group: Stubovi
Beam Results: max N1= 375 / min N1= -375 kN

4.6.6.3 **Димензионисање /** Reinforcement design

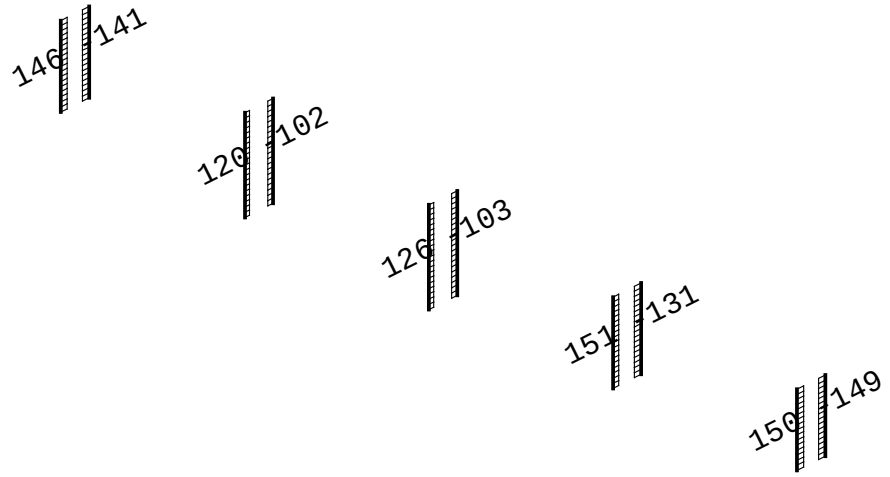
Comb 1





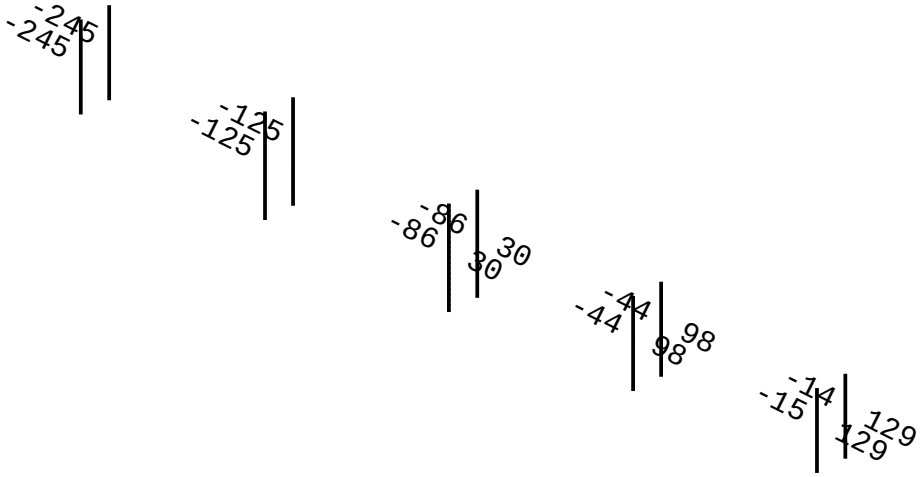


Load 361: [Comb 1]



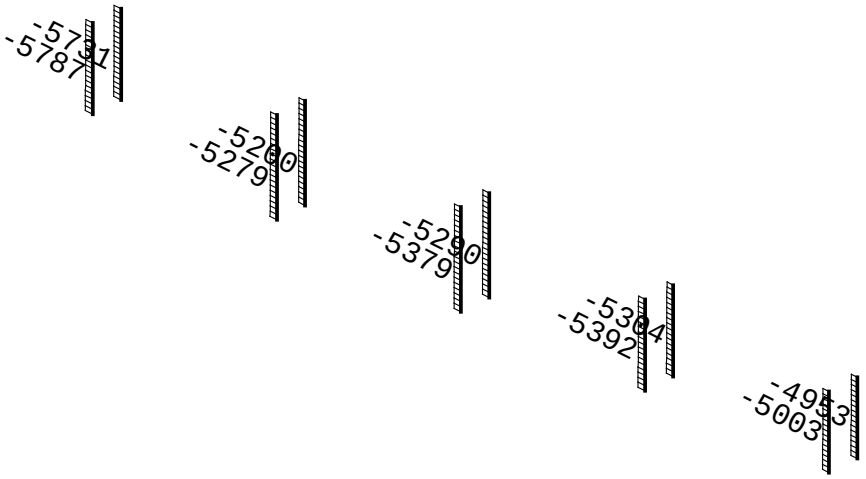
Group: Stubovi
Beam Results: max V3= 164 / min V3= -163 kN

Load 361: [Comb 1]



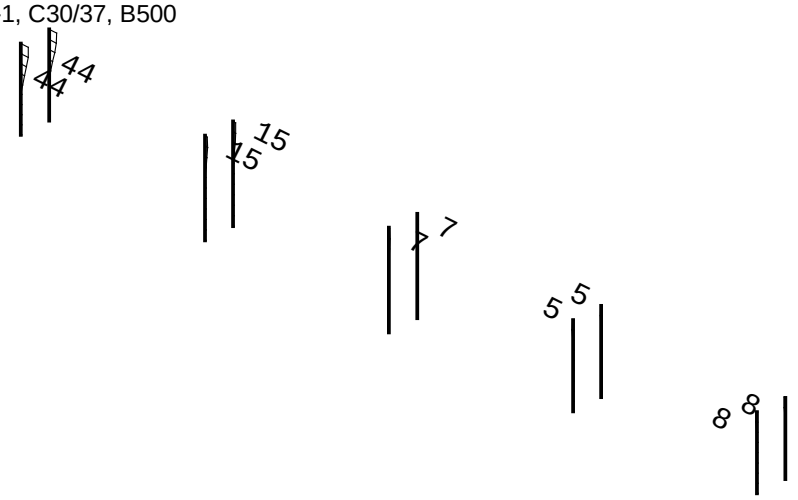
Group: Stubovi
Beam Results: max V2= 6393 / min V2= -5651 kN

Load 361: [Comb 1]



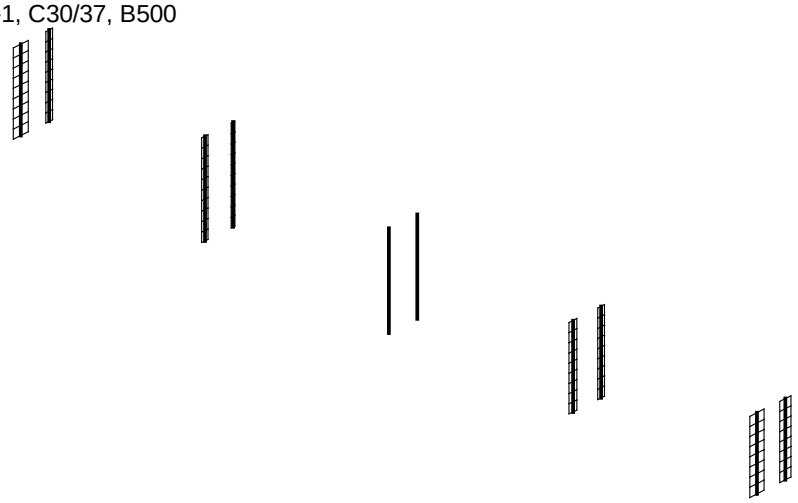
Group: Stubovi
Beam Results: max N1= 398 / min N1= -5787 kN

Governing load: [Comb 1]
SRPS EN 1992-1-1, C30/37, B500



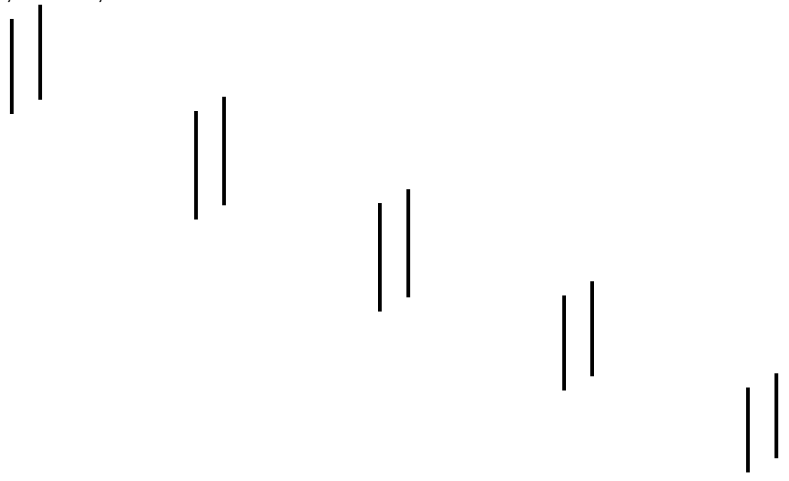
Group: Stubovi
Beam reinforcement: Aa2/Aa1

Governing load: [Comb 1]
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa3/Aa4

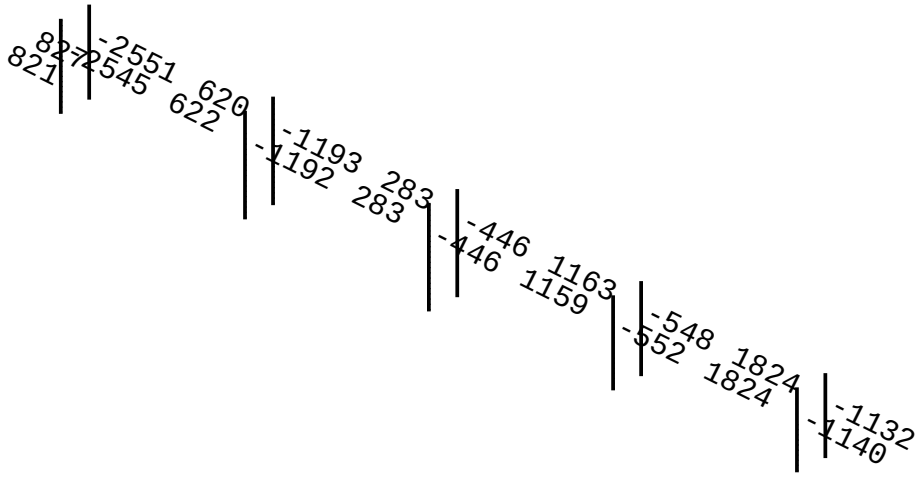
Governing load: [Comb 1]
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa,br

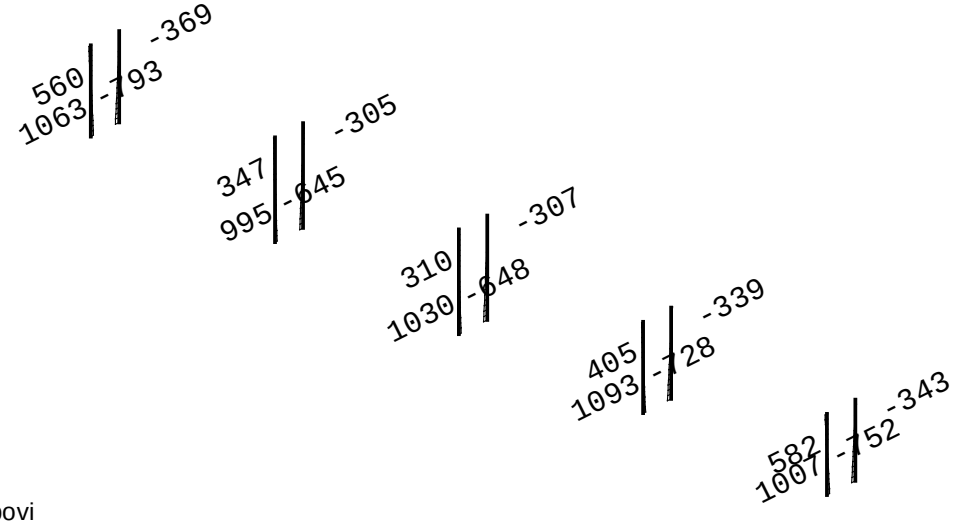
Comb 2

Load 362: [Comb 2]



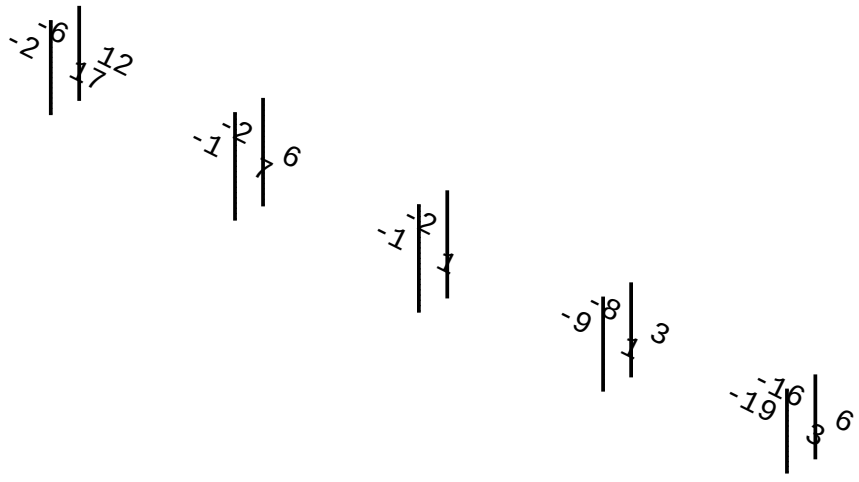
Group: Stubovi
Beam Results: max M3= 19605 / min M3= -24575 kNm

Load 362: [Comb 2]



Group: Stubovi
Beam Results: max M2= 1093 / min M2= -2100 kNm

Load 362: [Comb 2]

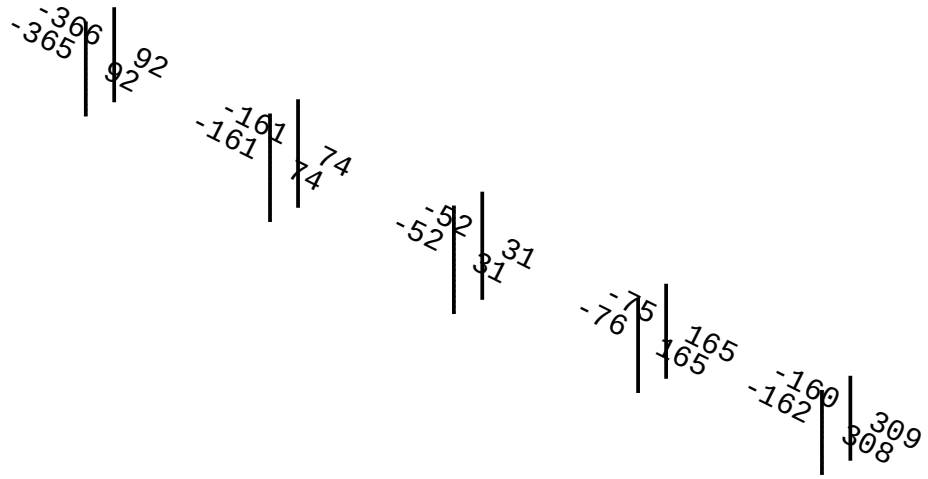


Group: Stubovi
Beam Results: max M1= 542 / min M1= -550 kNm

Load 362: [Comb 2]

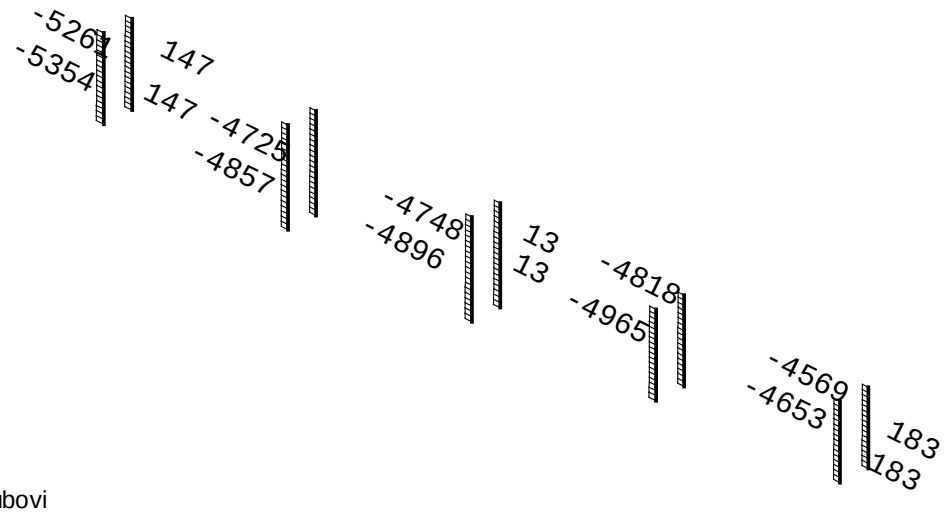
Group: Stubovi
Beam Results: max V3= 246 / min V3= -244 kN

Load 362: [Comb 2]



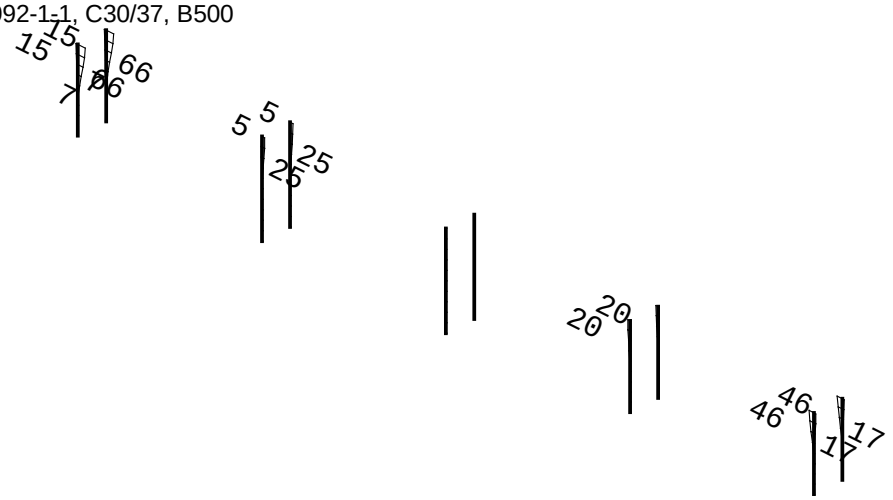
Group: Stubovi
Beam Results: max V2= 5763 / min V2= -5069 kN

Load 362: [Comb 2]



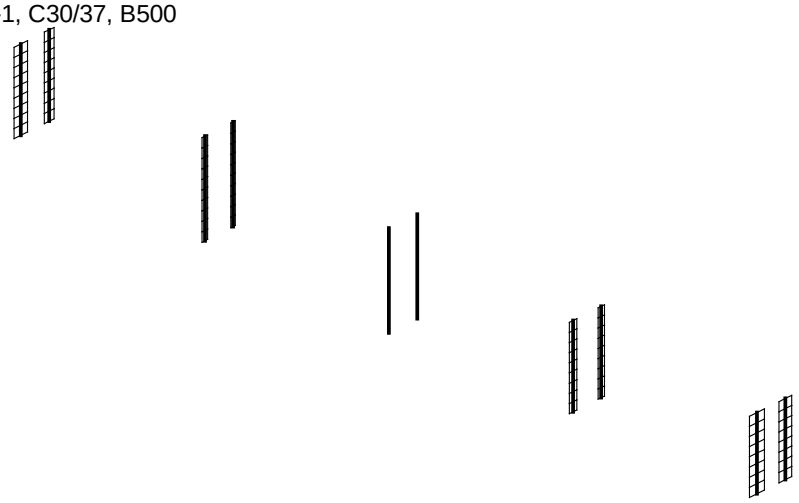
Group: Stubovi
Beam Results: max N1= 878 / min N1= -5354 kN

Governing load: [Comb 2]
SRPS EN 1992-1-1, C30/37, B500



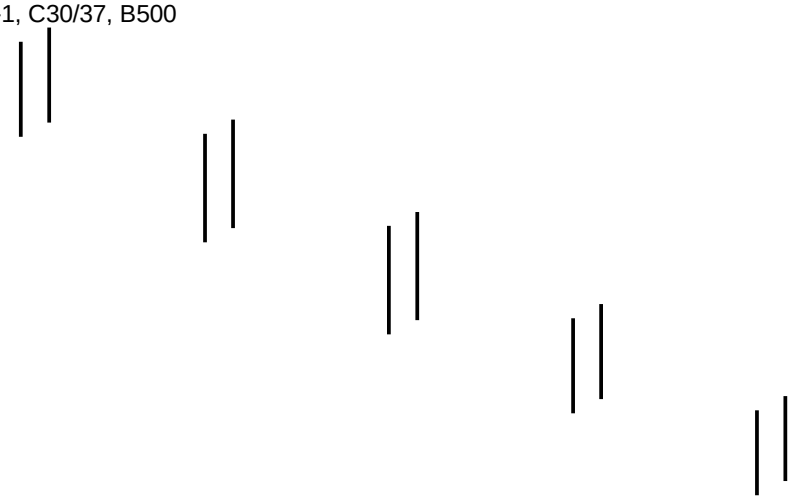
Group: Stubovi
Beam reinforcement: Aa2/Aa1

Governing load: [Comb 2]
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa3/Aa4

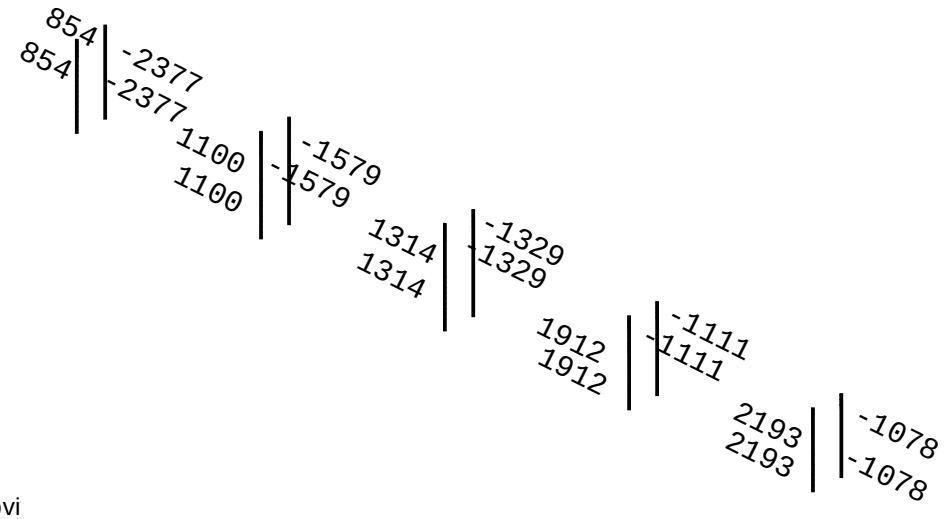
Governing load: [Comb 2]
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa,br

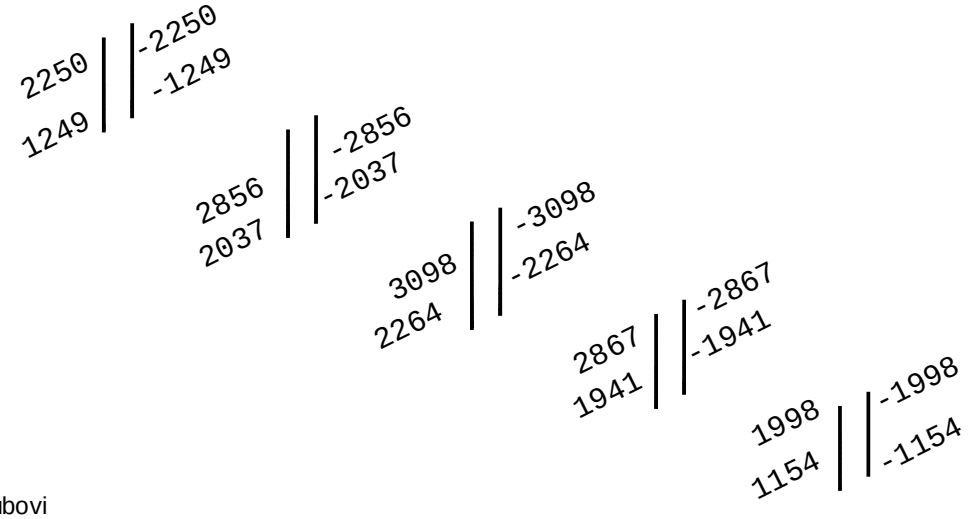
Comb 3

Load 363: [Comb 3]



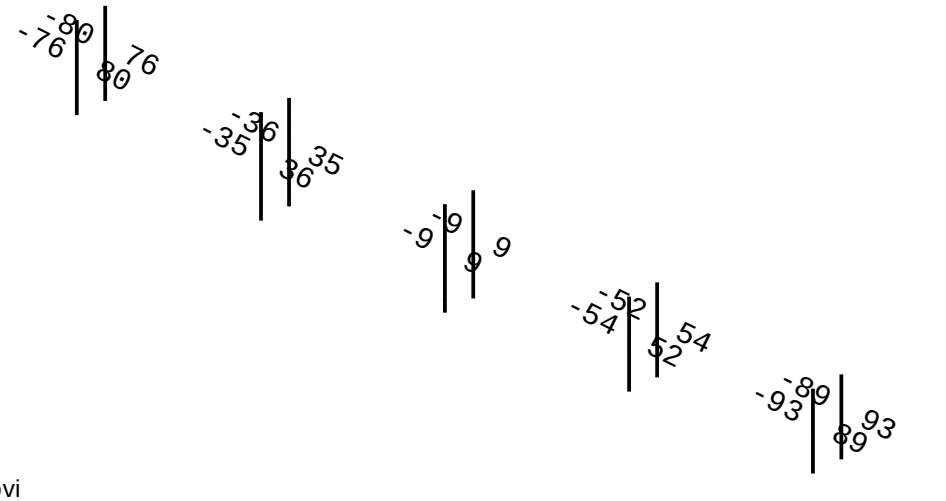
Group: Stubovi
Beam Results: max M3= 9579 / min M3= -14060 kNm

Load 363: [Comb 3]



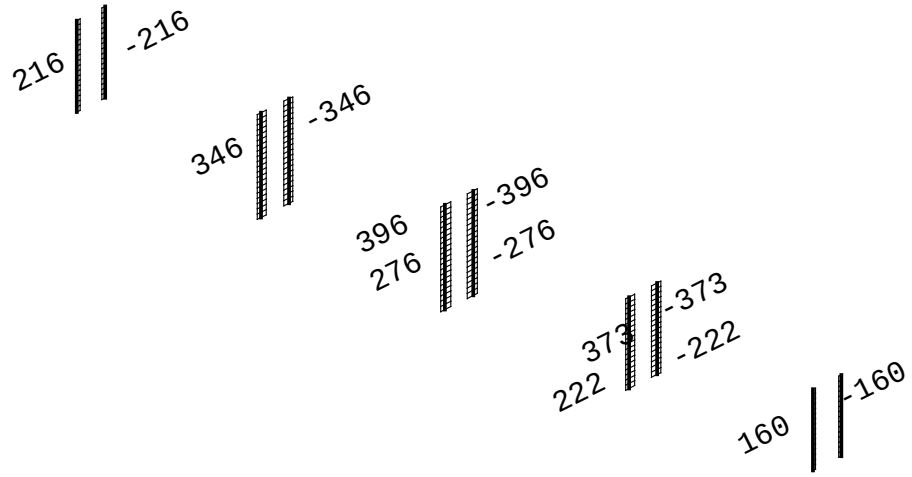
Group: Stubovi
Beam Results: max M2= 16706 / min M2= -16706 kNm

Load 363: [Comb 3]



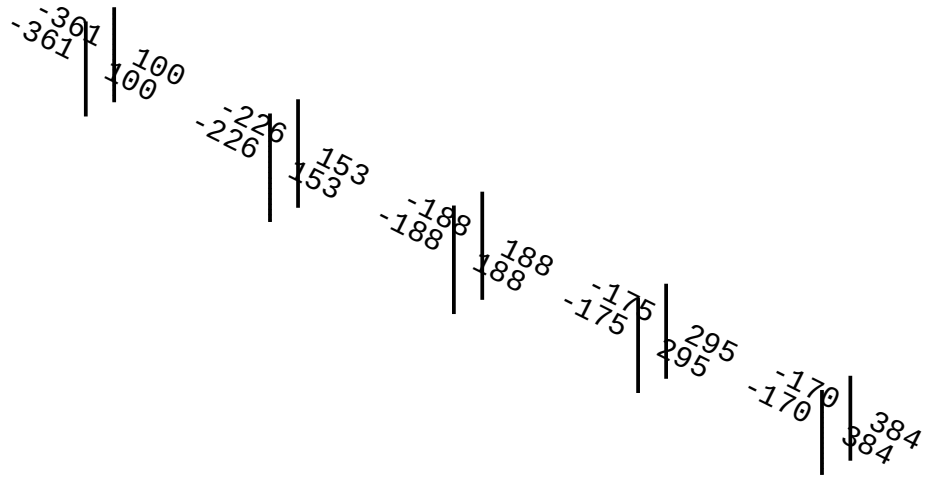
Group: Stubovi
Beam Results: max M1= 1883 / min M1= -1883 kNm

Load 363: [Comb 3]



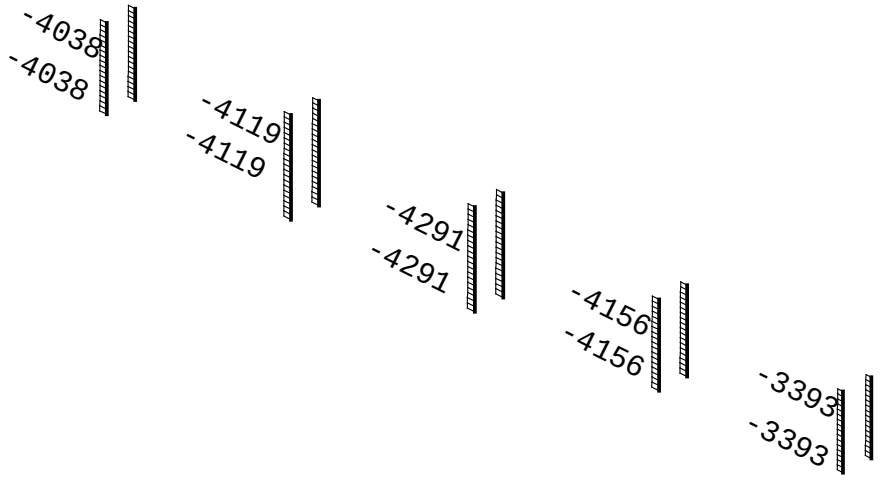
Group: Stubovi
Beam Results: max V3= 480 / min V3= -480 kN

Load 363: [Comb 3]



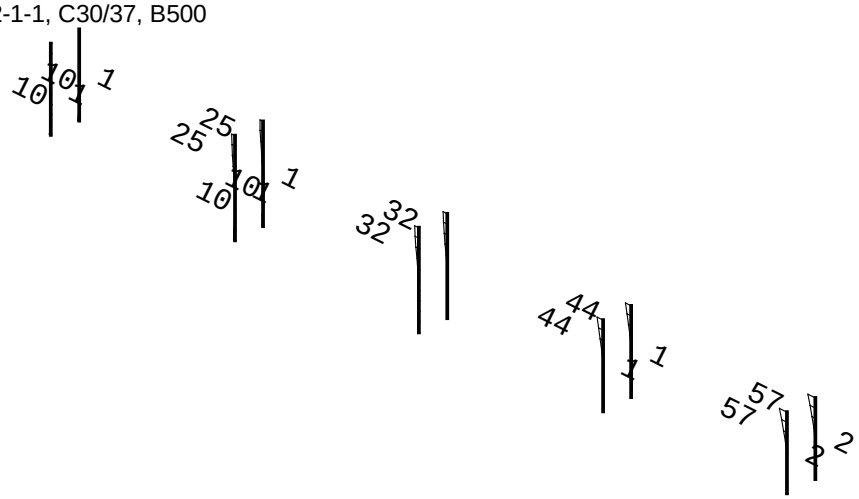
Group: Stubovi
Beam Results: max V2= 3337 / min V2= -2987 kN

Load 363: [Comb 3]



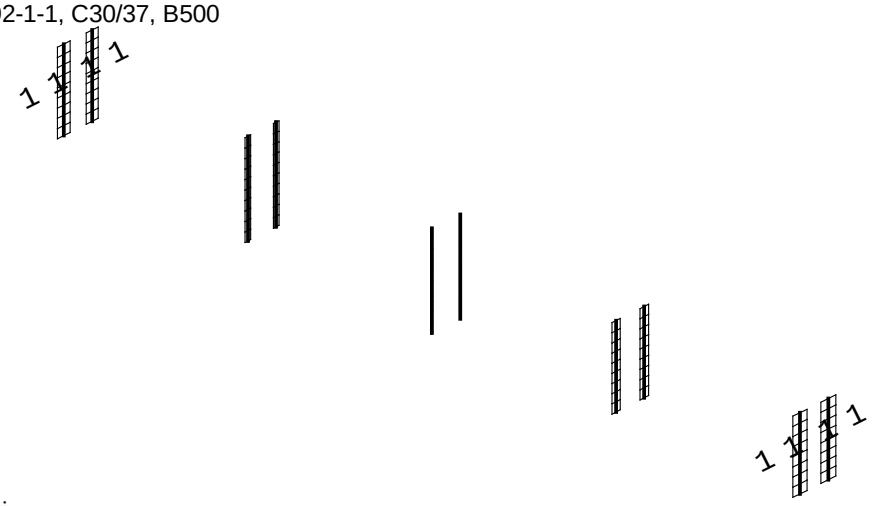
Group: Stubovi
Beam Results: max N1= 493 / min N1= -4291 kN

Governing load: [Comb 3]
SRPS EN 1992-1-1, C30/37, B500



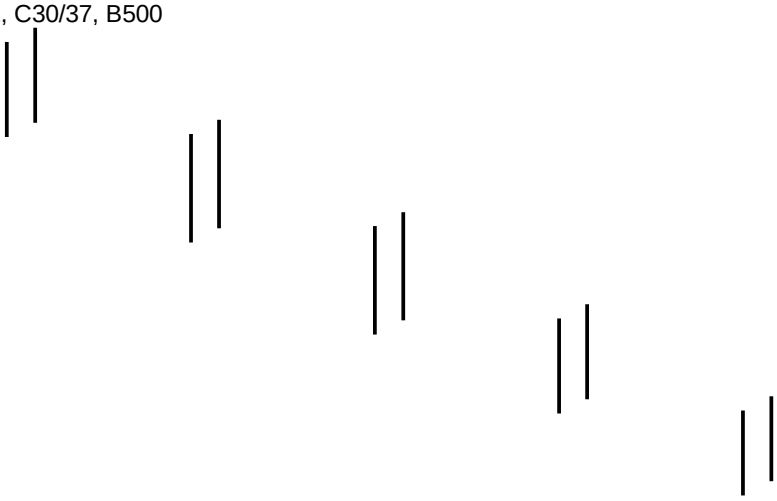
Group: Stubovi
Beam reinforcement: Aa2/Aa1

Governing load: [Comb 3]
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa3/Aa4

Governing load: [Comb 3]
SRPS EN 1992-1-1, C30/37, B500



Group: Stubovi
Beam reinforcement: Aa,br

Потребна арматура / required reinforcement

Вертикална арматура / Vertical reinforcement

Aa1,2max = 57 cm2

Aa3,4max = 1 cm2

Смичућа арматура / Shear reinforcement

Aa = 0 cm2/m

Минимална арматура / Minimum reinforcement

160x80 cm → Ab = 12800 cm2

Aa,min = 0.003xAb = 0.003x12800 = 38.4 cm2

Aa,min = (0.15xNu)/(fyk/1.15) = (0.15x5111)/(50/1.15) = 17.63 cm2

Усвојена арматура / provided reinforcement :

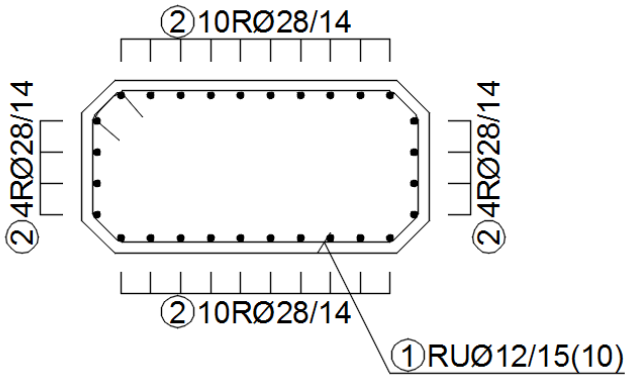
Aa1,2 → ±10Φ28 → Aa = 61.50 cm2

Aa3,4 → ±4Φ28 → Aa = 24,60 cm2

Смичућа арматура / Shear reinforcement

Aa = Φ12/10 → Aa = 11.30 cm/m → 1.0 m **На врху и дну /** at top and bottom

Aa = Φ12/15 → Aa = 7.53 cm/m → **у средини /** in the middle

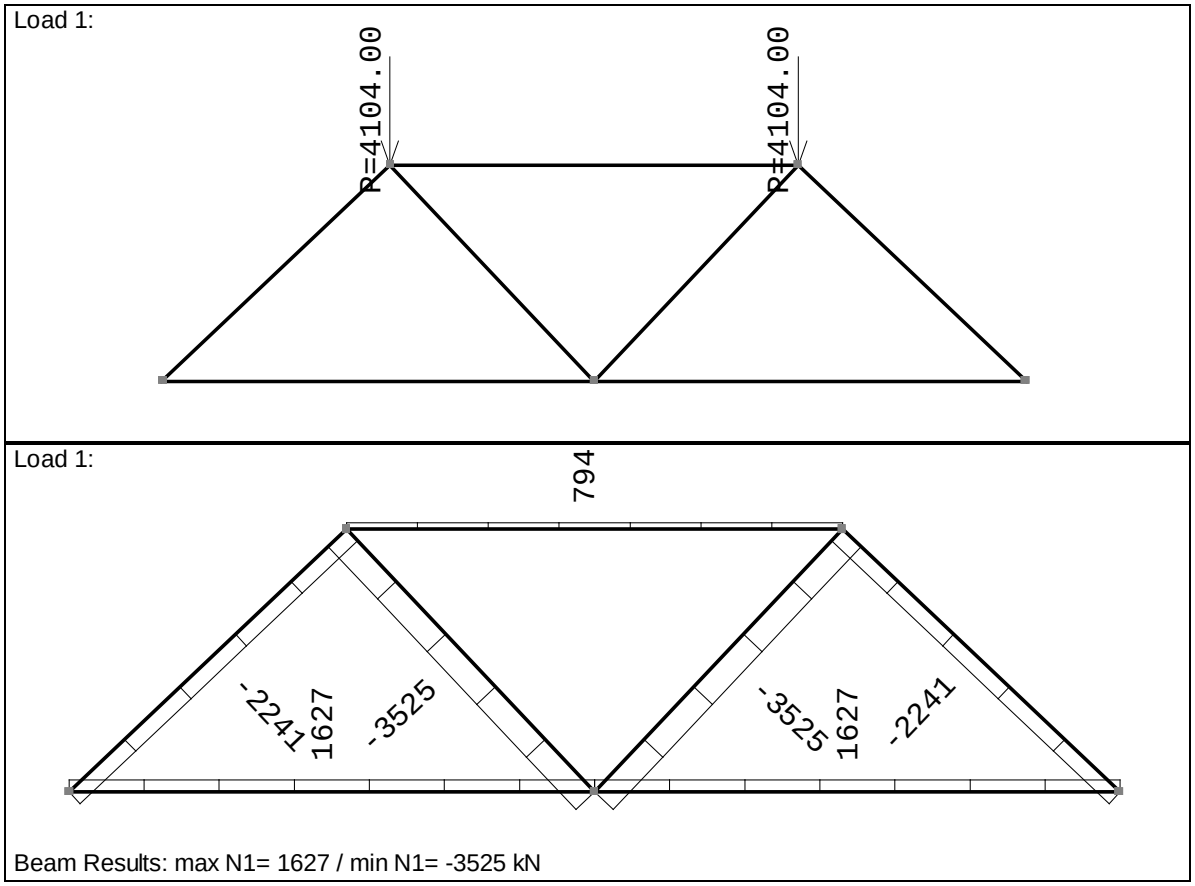


4.6.7 **Темељи /** Foundations

Користи се метод замењујуће решетке / strut-and-tie method

Меродавна је максимална аксијална сила у стубу / Maximum axial force in column e is relevant

Nd,max = 4104 kN



Потребна арматура / required reinforcement

Подужна арматура / Longitudinal reinforcement

Доња зона / Bottom zone

Z = 1627 kN

Aa = 1627/(0.6x50) = 54.23 cm2

Усвојена арматура / provided reinforcement :

12Ф25/15 → Aa = 58.89 cm2

Горња зона / Upper zone

Z = 794 kN

Aa = 794/(0.6x50) = 26.46 cm2

Усвојена арматура / provided reinforcement :

12Ф20/15 → Aa = 37.68 cm2

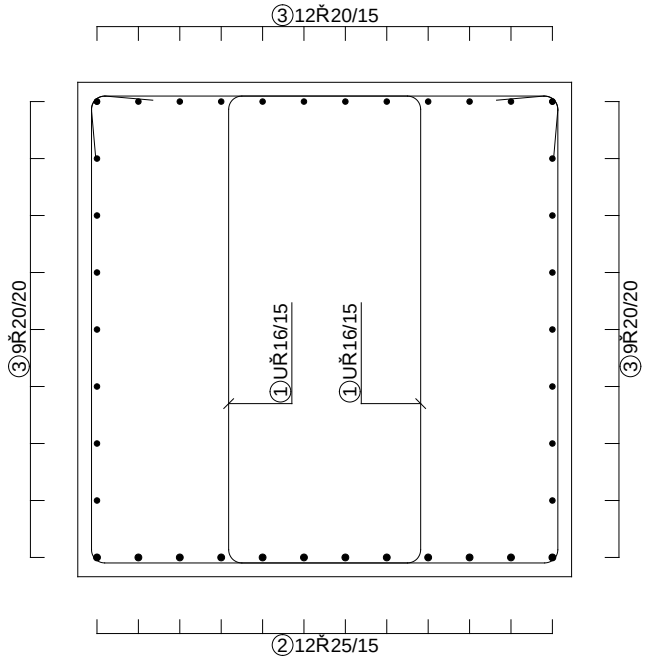
Смичућа арматура / Shear reinforcement

D1 = -3525 kN , D2 = -3525 kN

Све дијагонале су притиснуте / All diagonals are pressured

Усвојена арматура / provided reinforcement :

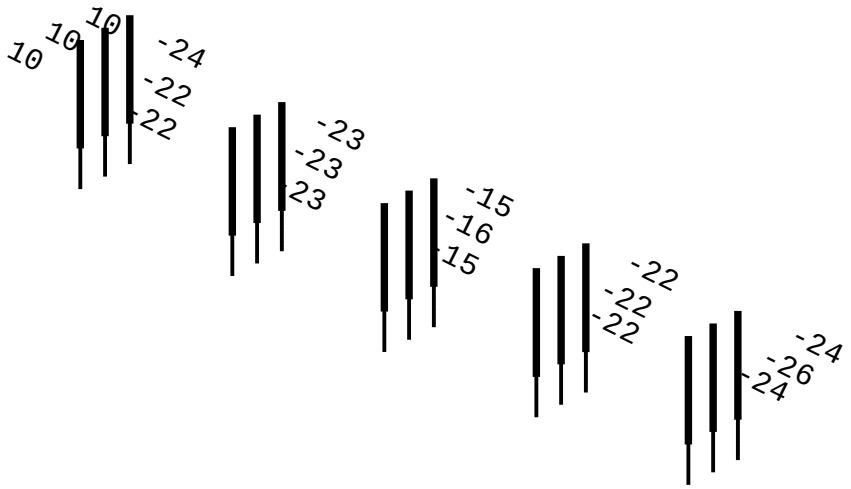
2xΦ16/15 → Aa = 13.40x2 = 26.80 cm2/m



4.6.8 **Шипови /** Piles

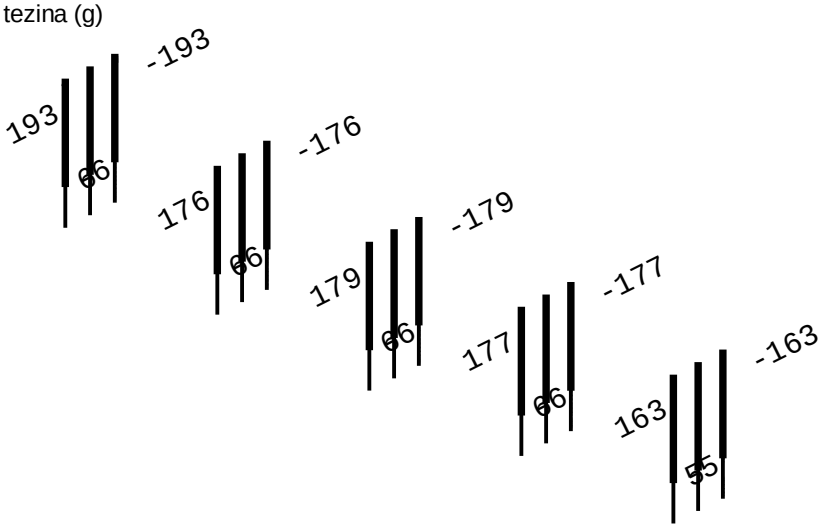
4.6.8.1 **Пресечне силе и деформације /** Internal forces and deformations

Load 1: Sopstvena tezina (g)



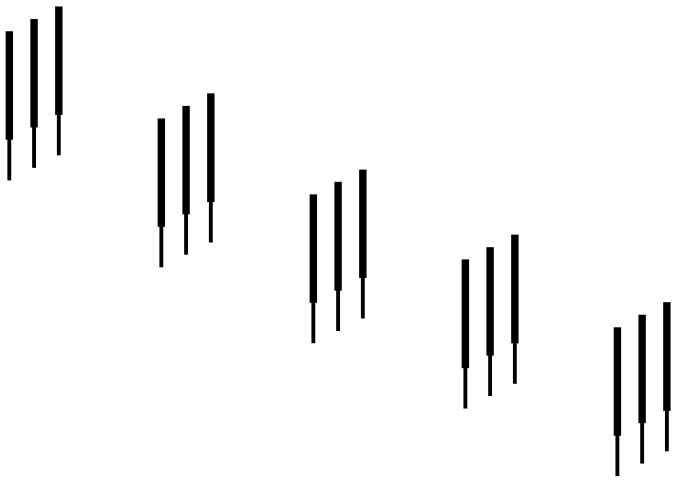
Group: Sipovi
Beam Results: max M3= 7308 / min M3= -9639 kNm

Load 1: Sopstvena tezina (g)



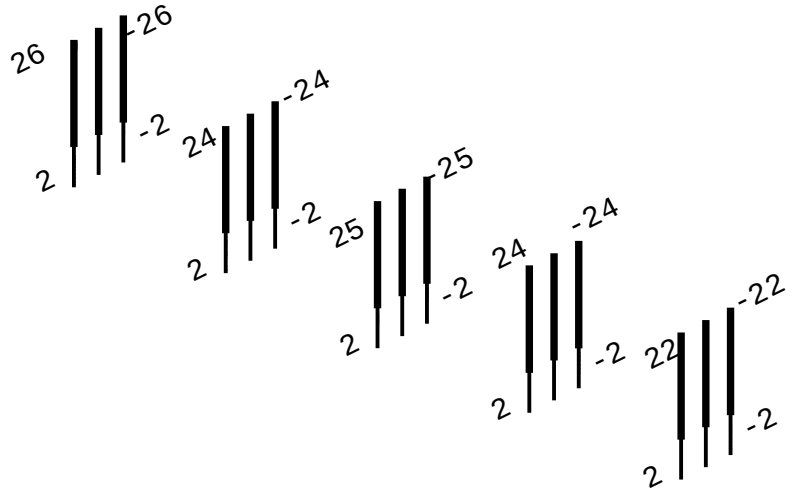
Group: Sipovi
Beam Results: max M2= 405 / min M2= -405 kNm

Load 1: Sopstvena tezina (g)



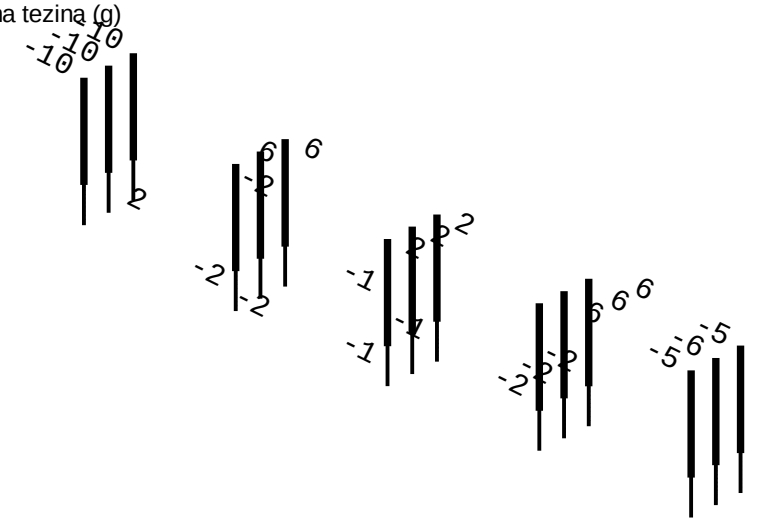
Group: Sipovi
Beam Results: max M1= 24 / min M1= -24 kNm

Load 1: Sopstvena tezina (g)



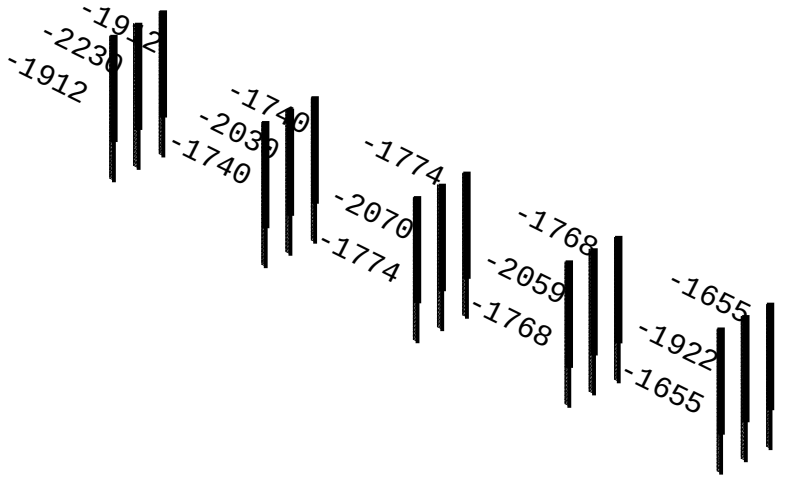
Group: Sipovi
Beam Results: max V3= 69 / min V3= -69 kN

Load 1: Sopstvena tezina (g)



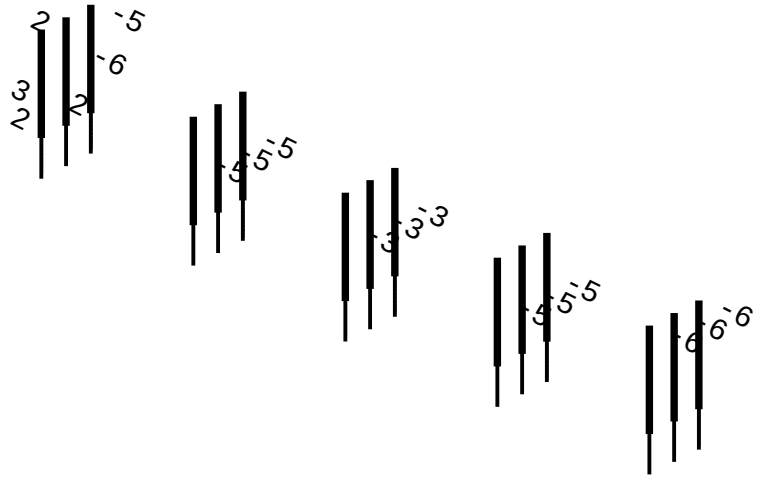
Group: Sipovi
Beam Results: max V2= 2541 / min V2= -2194 kN

Load 1: Sopstvena tezina (g)



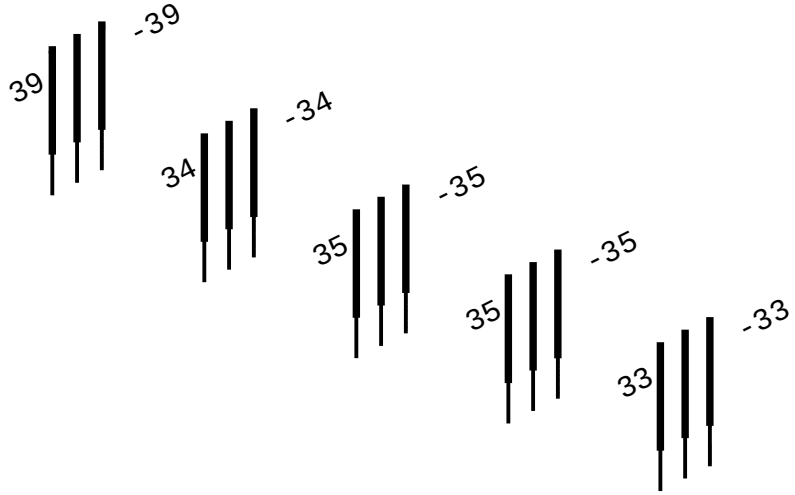
Group: Sipovi
Beam Results: max N1= 46 / min N1= -2654 kN

Load 2: Dodato stalno



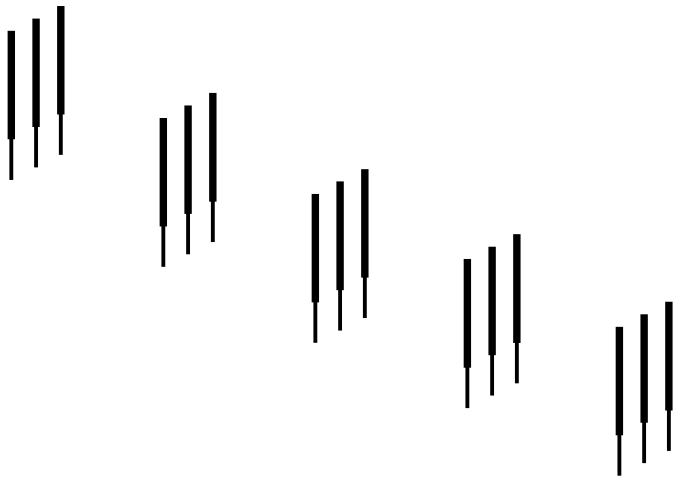
Group: Sipovi
Beam Results: max M3= 1727 / min M3= -2300 kNm

Load 2: Dodato stalno



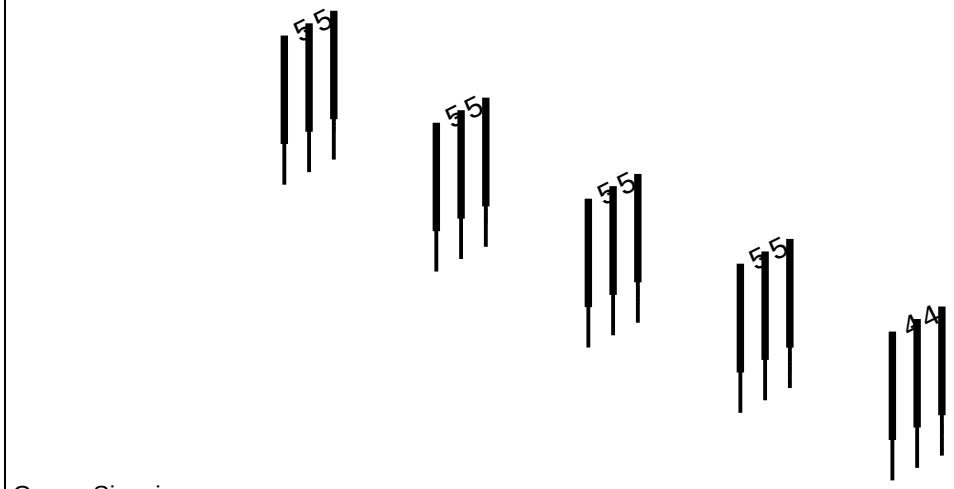
Group: Sipovi
Beam Results: max M2= 82 / min M2= -82 kNm

Load 2: Dodato stalno



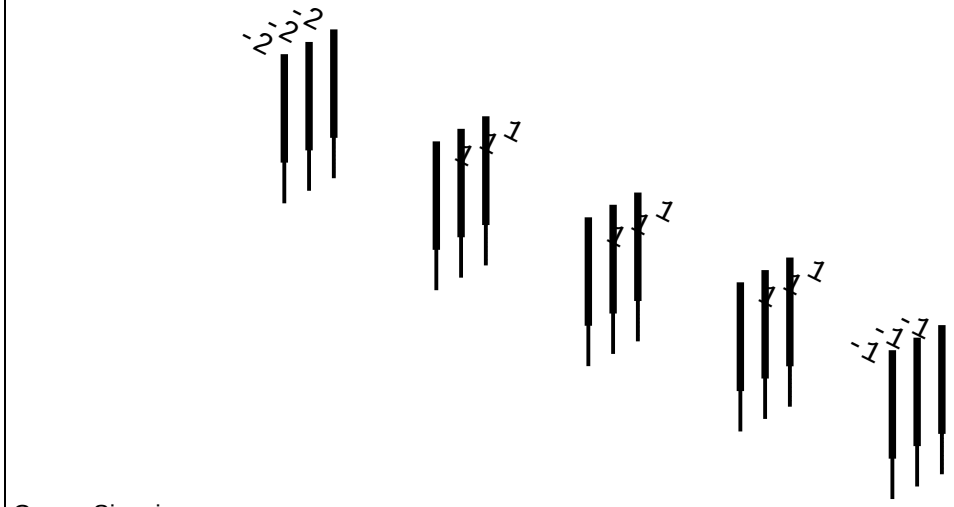
Group: Sipovi
Beam Results: max M1= 6 / min M1= -6 kNm

Load 2: Dodato stalno



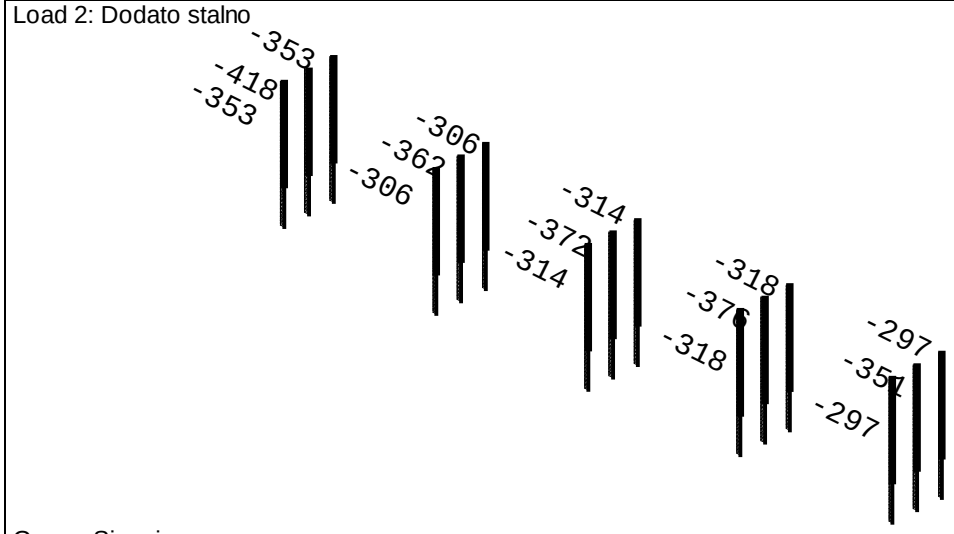
Group: Sipovi
Beam Results: max V3= 14 / min V3= -14 kN

Load 2: Dodato stalno



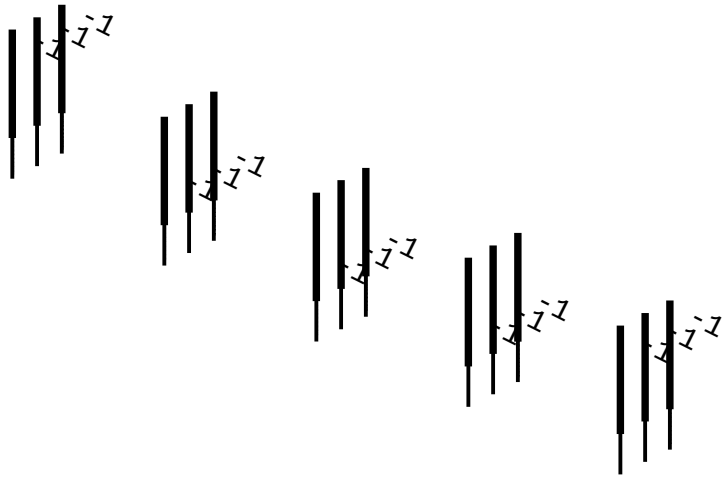
Group: Sipovi
Beam Results: max V2= 603 / min V2= -521 kN

Load 2: Dodato stalno



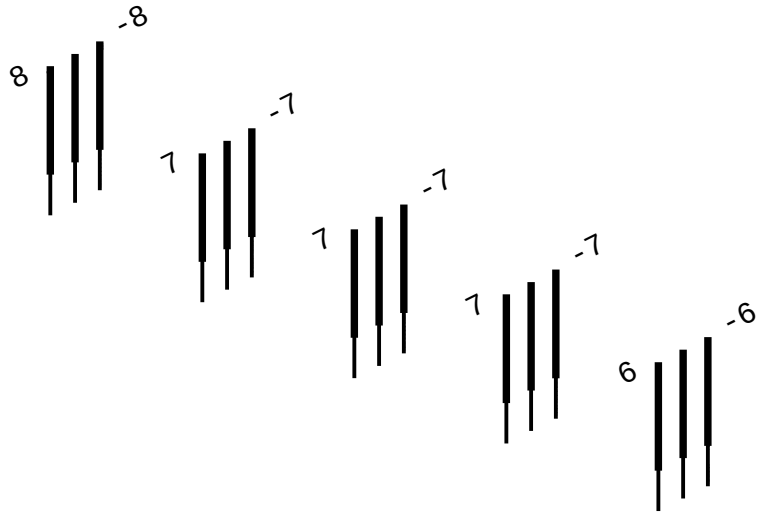
Group: Sipovi
Beam Results: max N1= 9 / min N1= -562 kN

Load 3: UDL (20%)



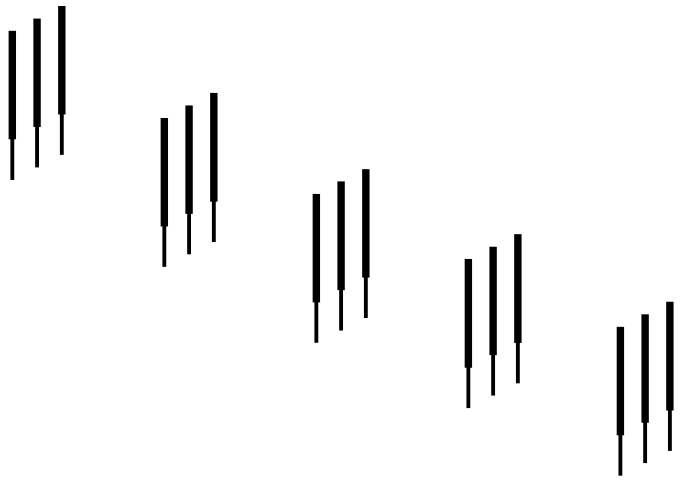
Group: Sipovi
Beam Results: max M3= 337 / min M3= -448 kNm

Load 3: UDL (20%)



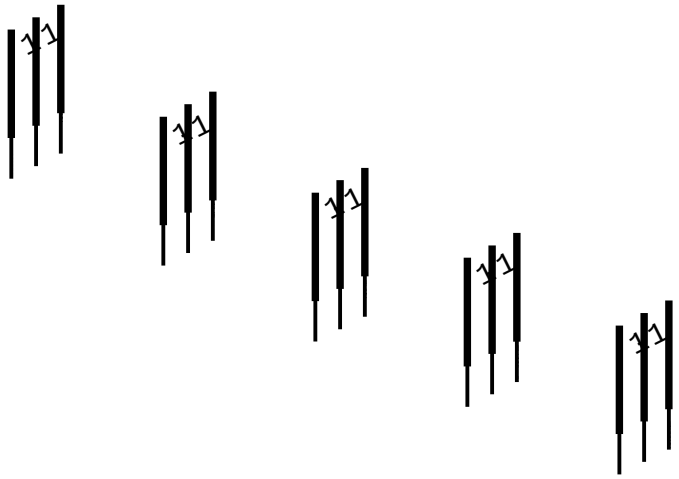
Group: Sipovi
Beam Results: max M2= 16 / min M2= -16 kNm

Load 3: UDL (20%)



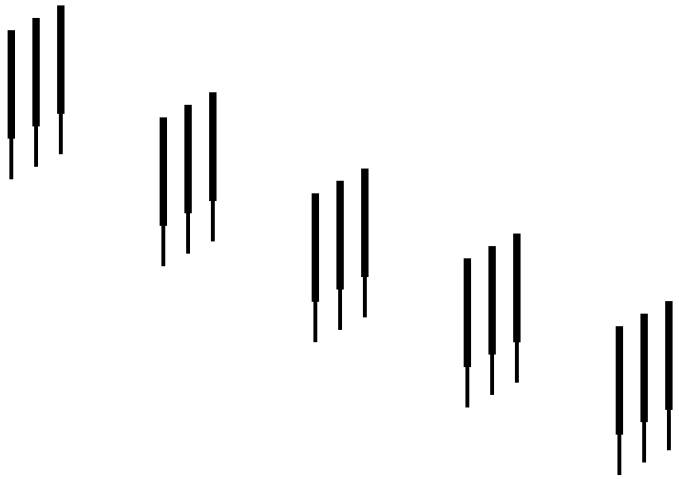
Group: Sipovi
Beam Results: max M1= 1 / min M1= -1 kNm

Load 3: UDL (20%)



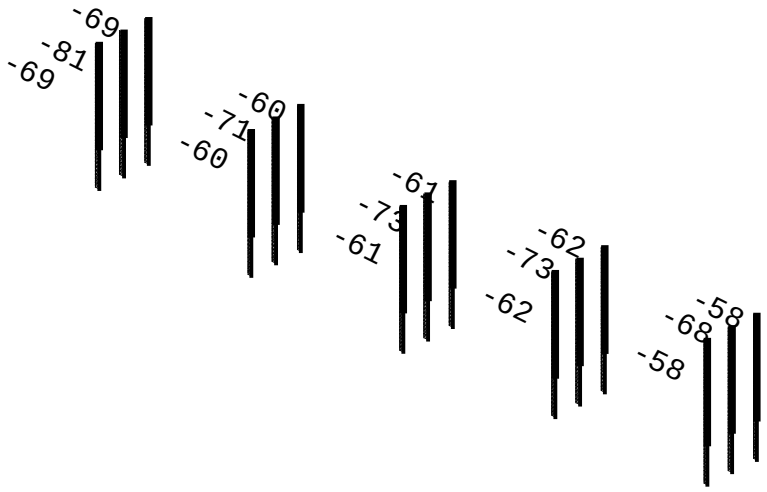
Group: Sipovi
Beam Results: max V3= 3 / min V3= -3 kN

Load 3: UDL (20%)



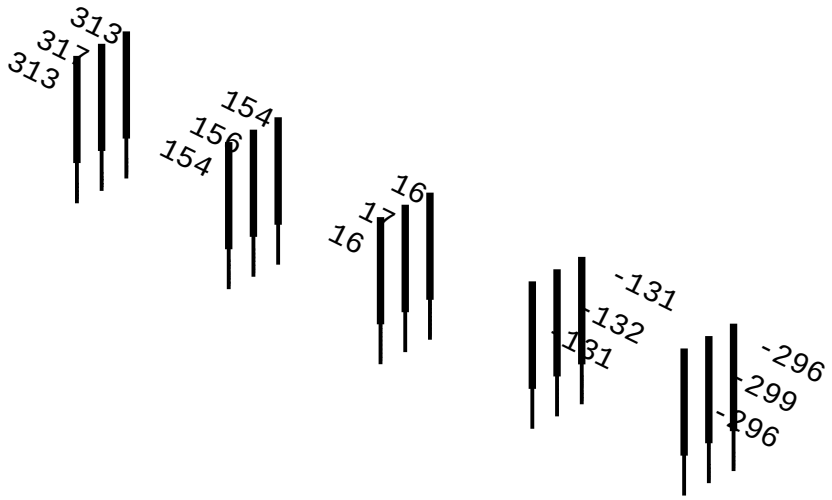
Group: Sipovi
Beam Results: max V2= 118 / min V2= -101 kN

Load 3: UDL (20%)



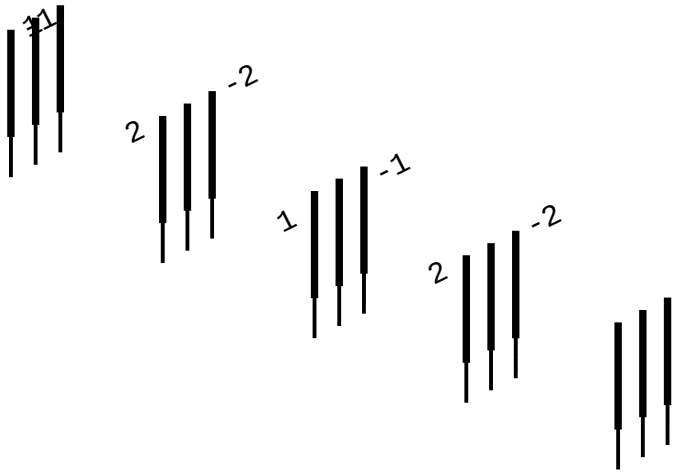
Group: Sipovi
Beam Results: max N1= 2 / min N1= -110 kN

Load 4: Skupljanje



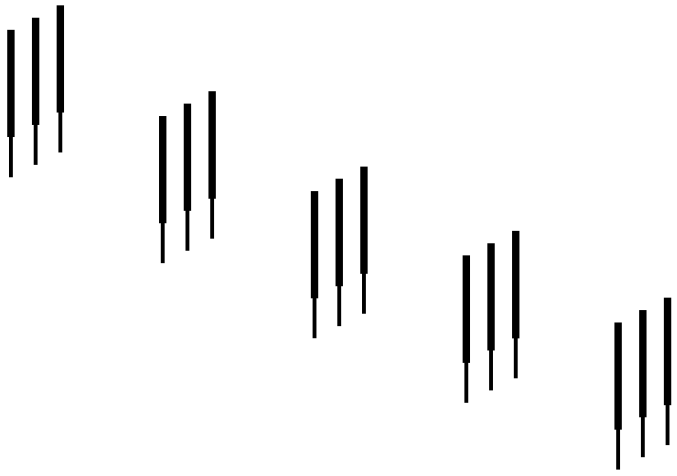
Group: Sipovi
Beam Results: max M3= 818 / min M3= -696 kNm

Load 4: Skupljanje



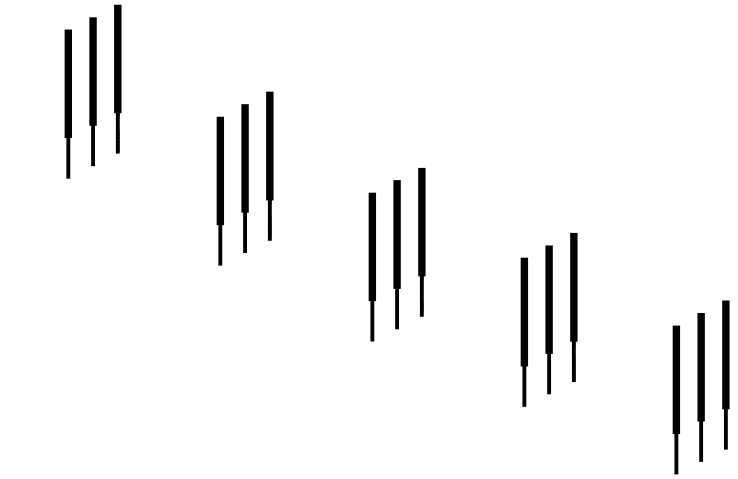
Group: Sipovi
Beam Results: max M2= 140 / min M2= -149 kNm

Load 4: Skupljanje



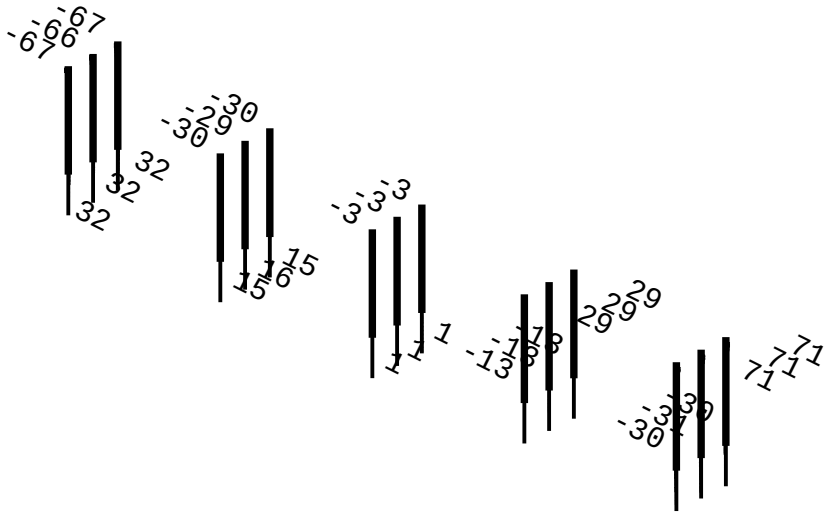
Group: Sipovi
Beam Results: max M1= 194 / min M1= -194 kNm

Load 4: Skupljanje



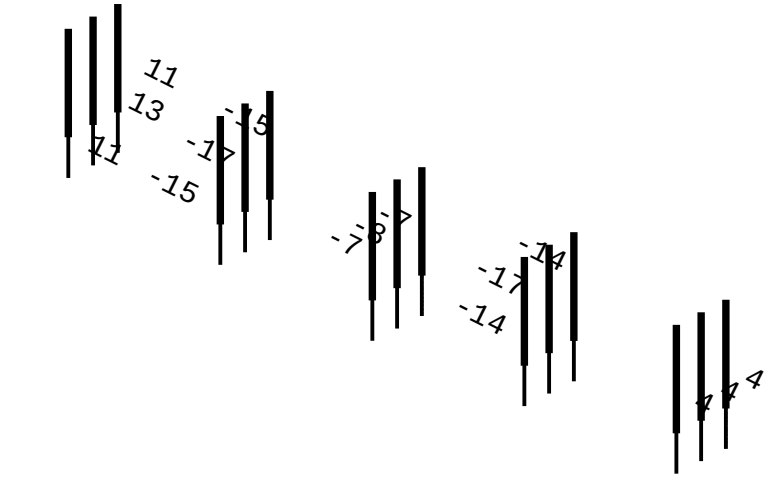
Group: Sipovi
Beam Results: max V3= 78 / min V3= -78 kN

Load 4: Skupljanje



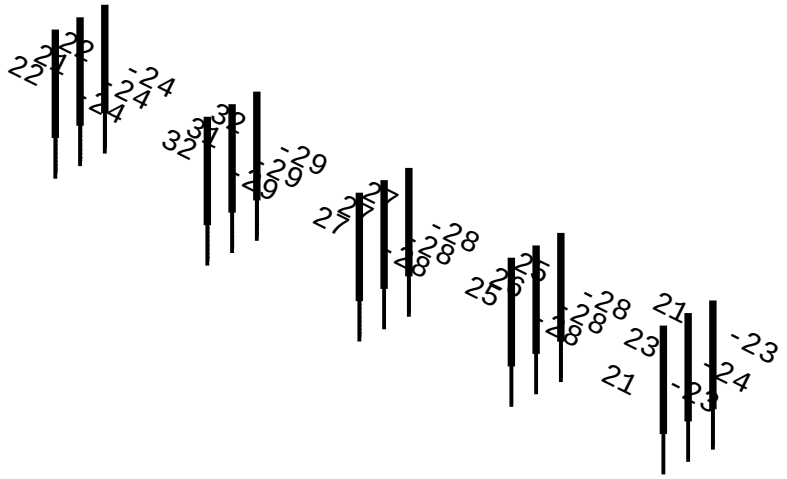
Group: Sipovi
Beam Results: max V2= 117 / min V2= -111 kN

Load 4: Skupljanje



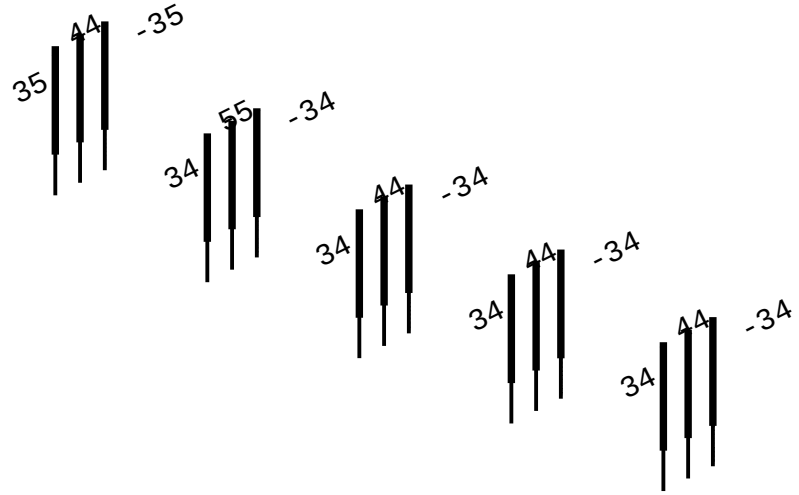
Group: Sipovi
Beam Results: max N1= 330 / min N1= -23 kN

Load 5: TS



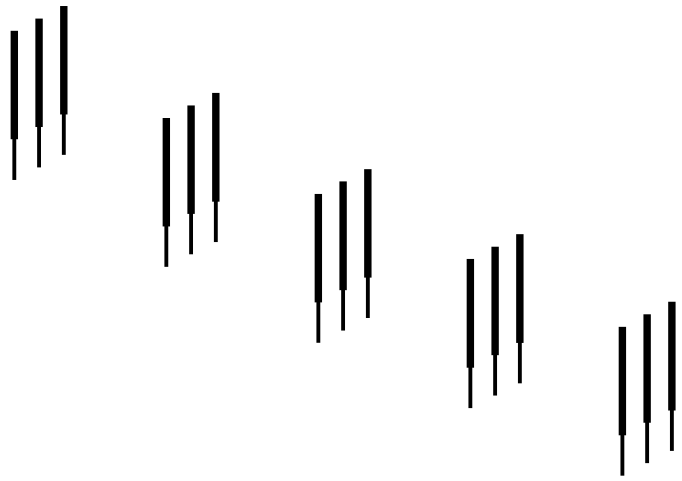
Group: Sipovi
Beam Results: max M3= 4191 / min M3= -2400 kNm

Load 5: TS



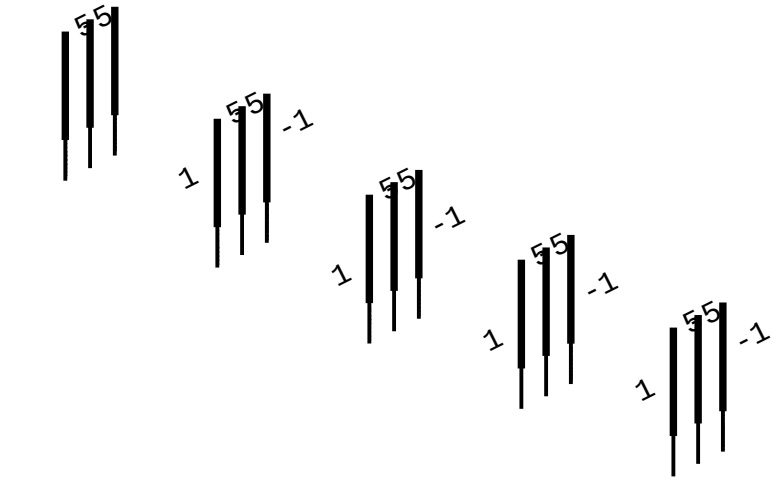
Group: Sipovi
Beam Results: max M2= 78 / min M2= -78 kNm

Load 5: TS



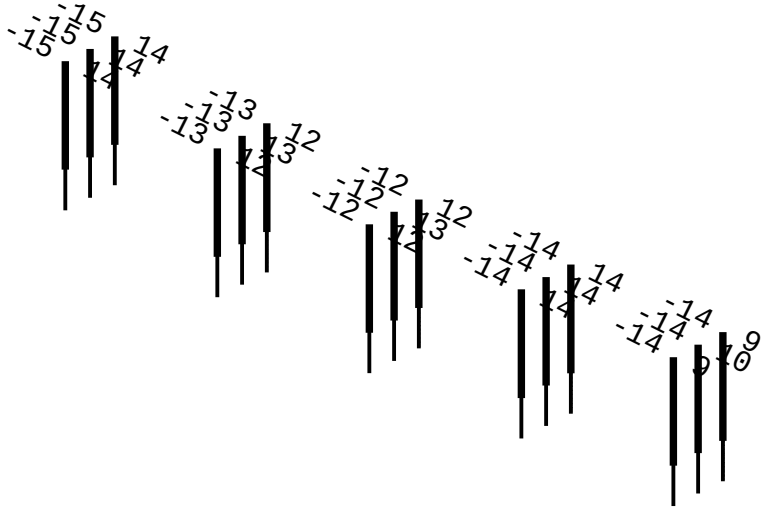
Group: Sipovi
Beam Results: max M1= 23 / min M1= -23 kNm

Load 5: TS



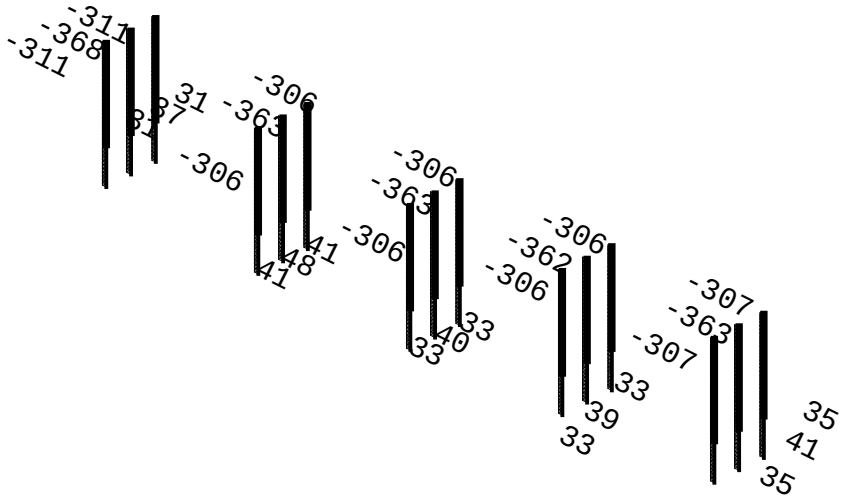
Group: Sipovi
Beam Results: max V3= 15 / min V3= -15 kN

Load 5: TS



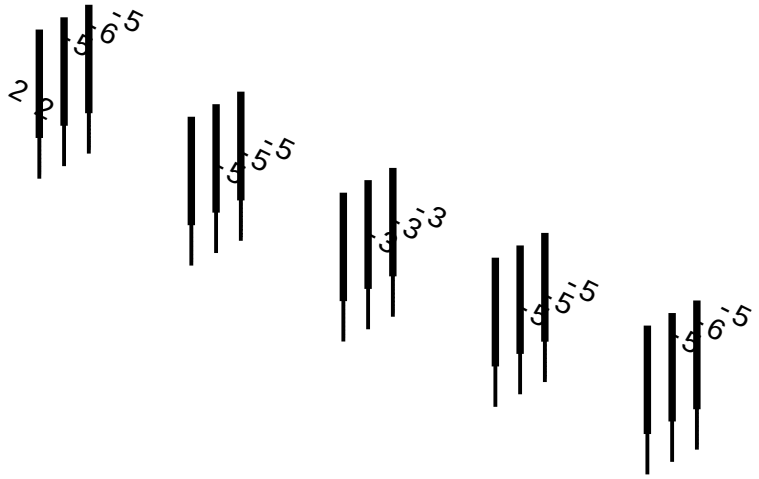
Group: Sipovi
Beam Results: max V2= 974 / min V2= -968 kN

Load 5: TS



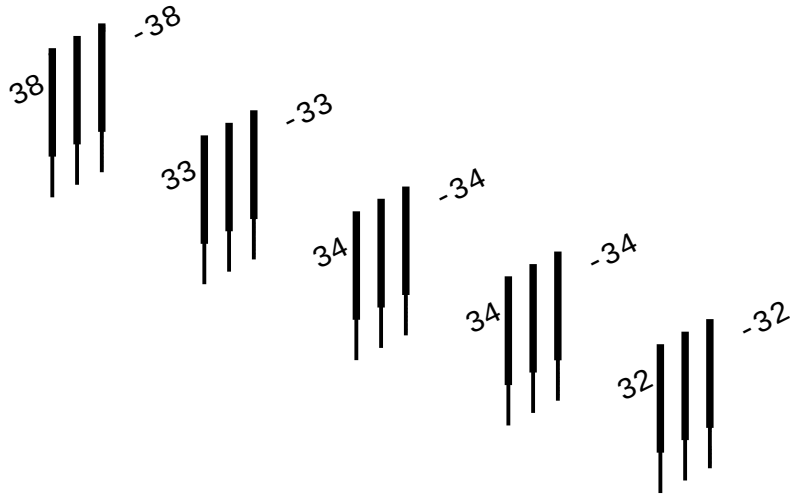
Group: Sipovi
Beam Results: max N1= 65 / min N1= -495 kN

Load 6: UDL



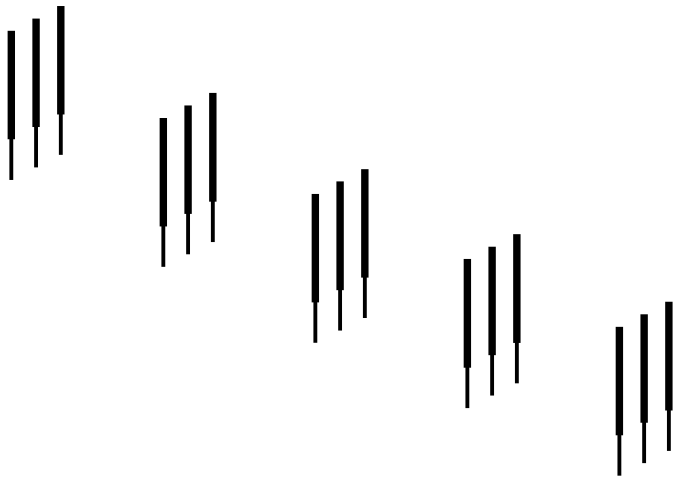
Group: Sipovi
Beam Results: max M3= 1683 / min M3= -2241 kNm

Load 6: UDL



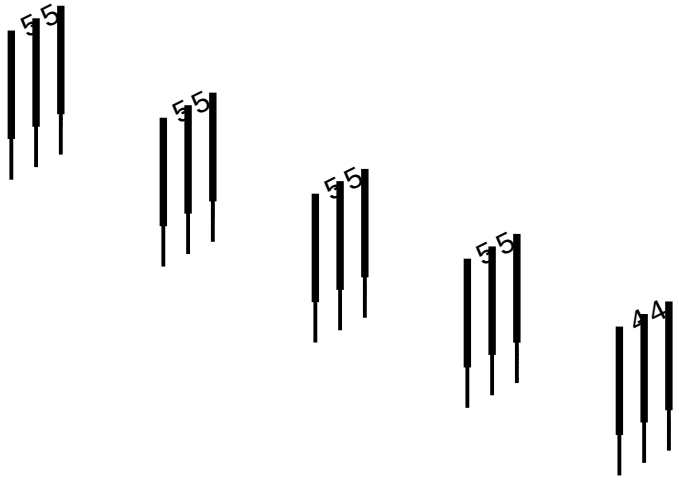
Group: Sipovi
Beam Results: max M2= 80 / min M2= -80 kNm

Load 6: UDL



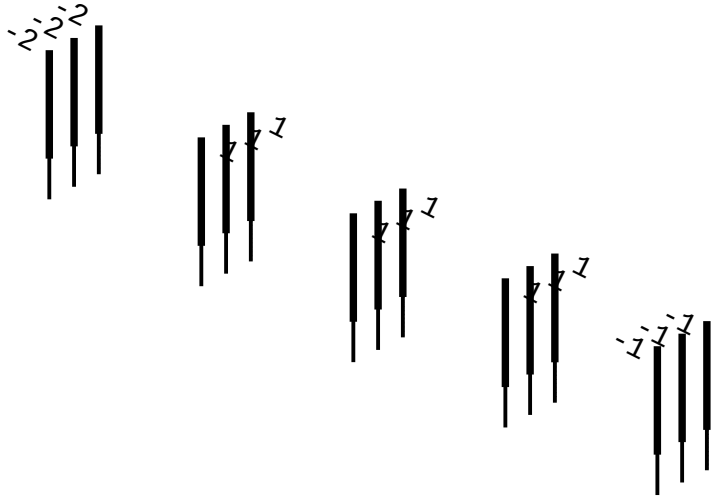
Group: Sipovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 6: UDL



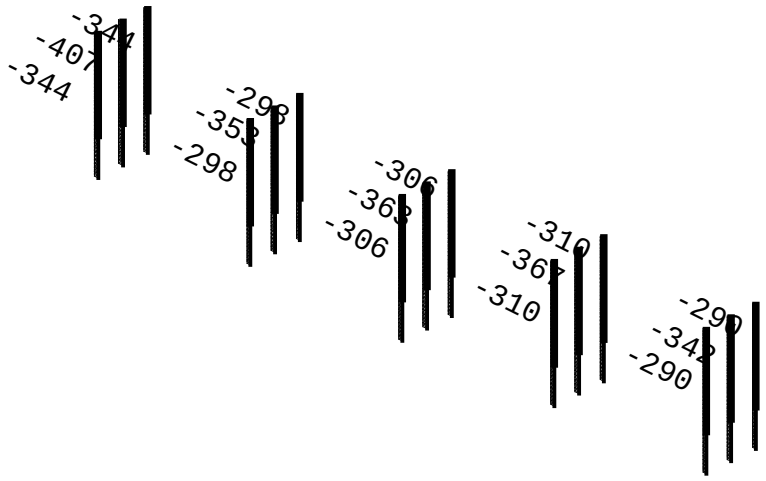
Group: Sipovi
Beam Results: max V3= 13 / min V3= -13 kN

Load 6: UDL



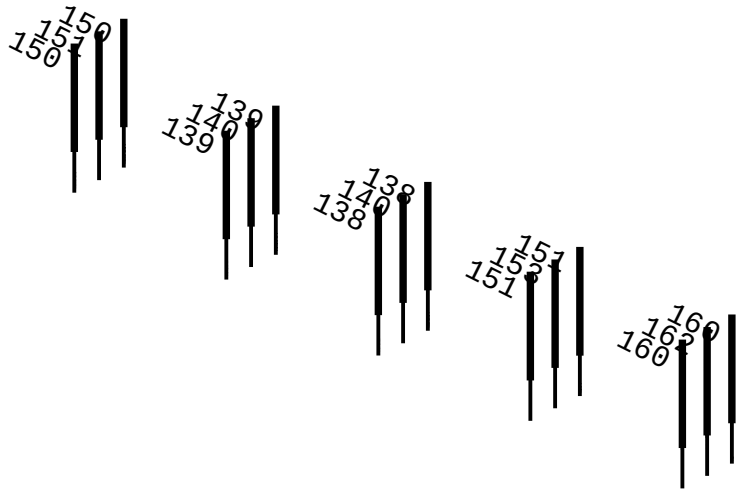
Group: Sipovi
Beam Results: max V2= 588 / min V2= -507 kN

Load 6: UDL



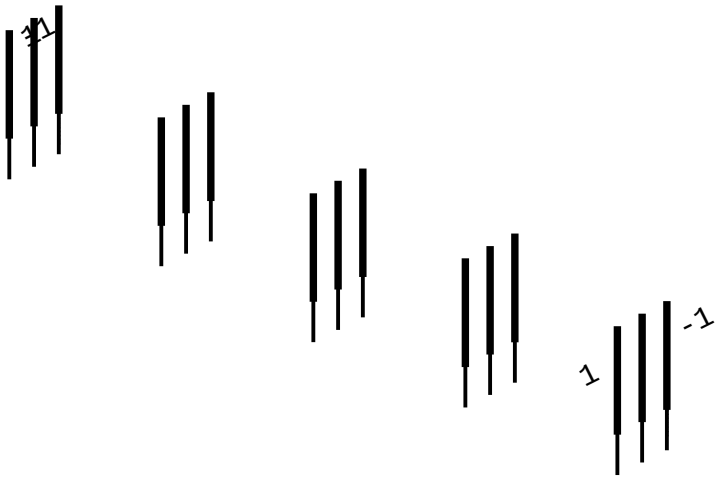
Group: Sipovi
Beam Results: max N1= 9 / min N1= -548 kN

Load 7: Kocenje



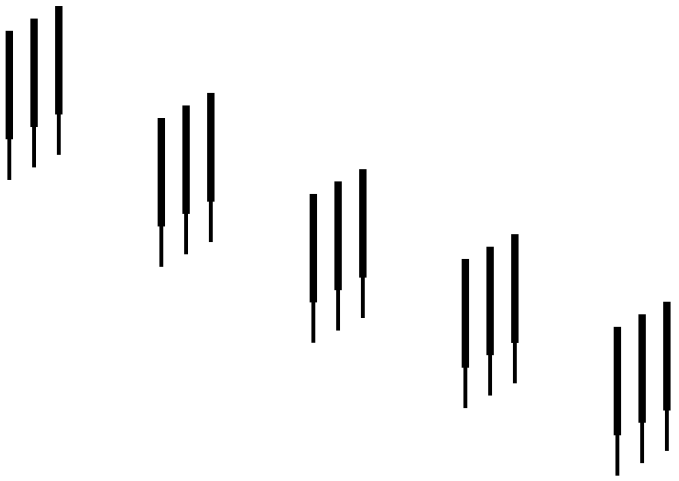
Group: Sipovi
Beam Results: max M3= 417 / min M3= -422 kNm

Load 7: Kocenje



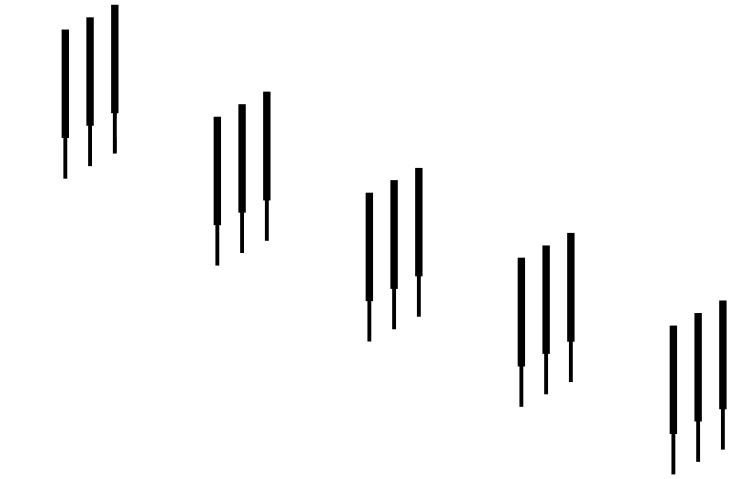
Group: Sipovi
Beam Results: max M2= 81 / min M2= -2 kNm

Load 7: Kocenje



Group: Sipovi
Beam Results: max M1= 94 / min M1= -94 kNm

Load 7: Kocenje

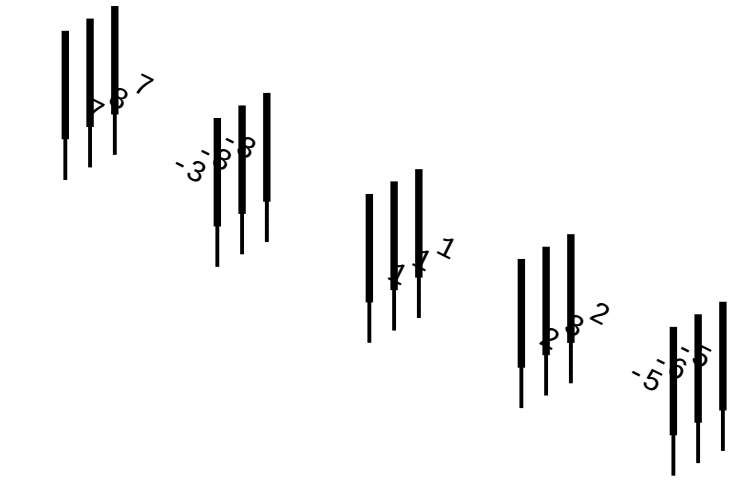


Group: Sipovi
Beam Results: max V3= 43 / min V3= -43 kN

Load 7: Kocenje

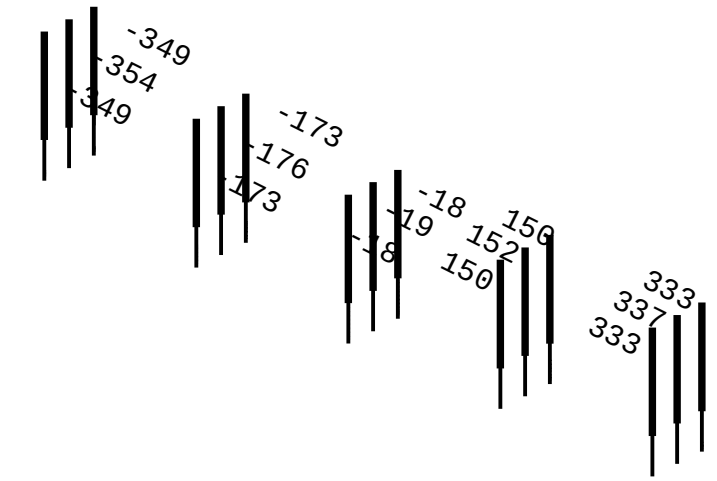
Group: Sipovi
Beam Results: max V2= 36 / min V2= -64 kN

Load 7: Kocenje



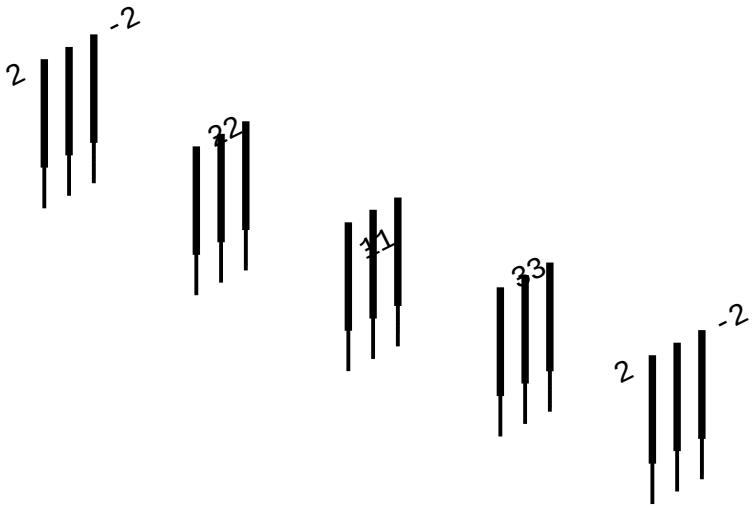
Group: Sipovi
Beam Results: max N1= 66 / min N1= -91 kN

Load 8: to+34



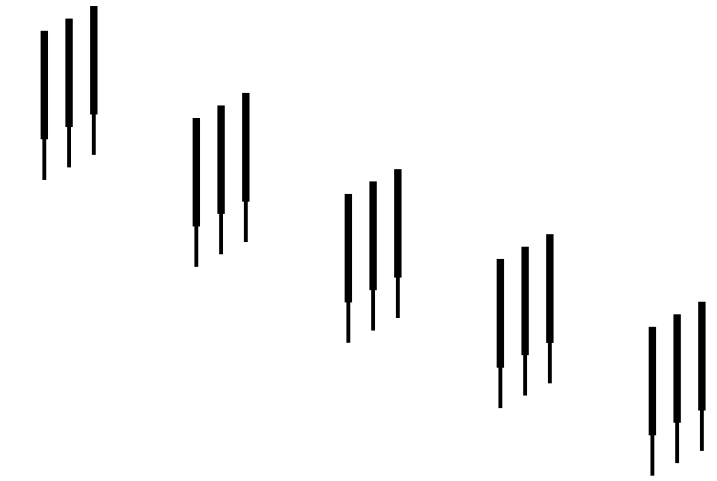
Group: Sipovi
Beam Results: max M3= 749 / min M3= -1090 kNm

Load 8: to+34



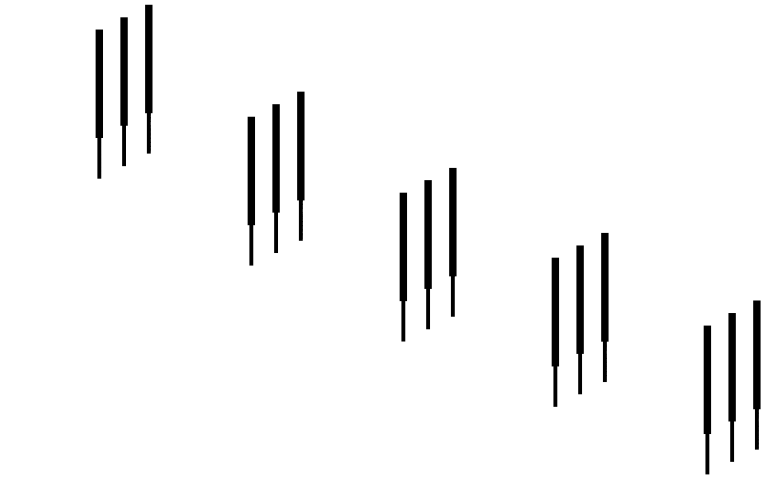
Group: Sipovi
Beam Results: max M2= 163 / min M2= -154 kNm

Load 8: to+34



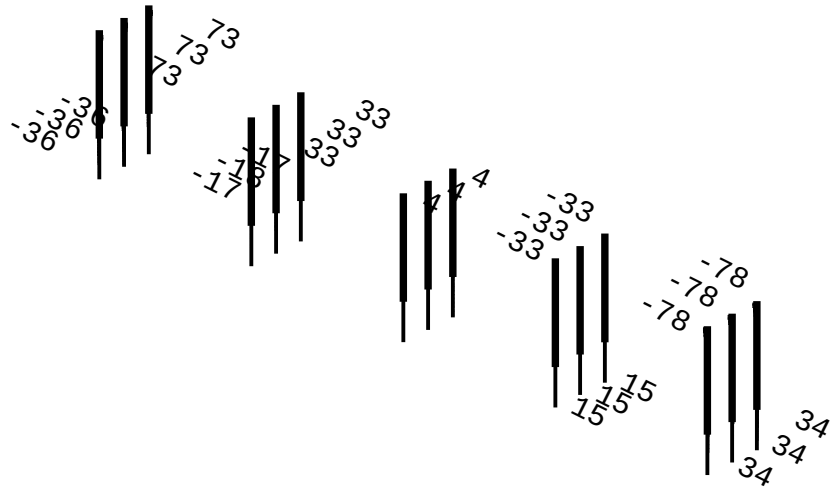
Group: Sipovi
Beam Results: max M1= 221 / min M1= -221 kNm

Load 8: to+34



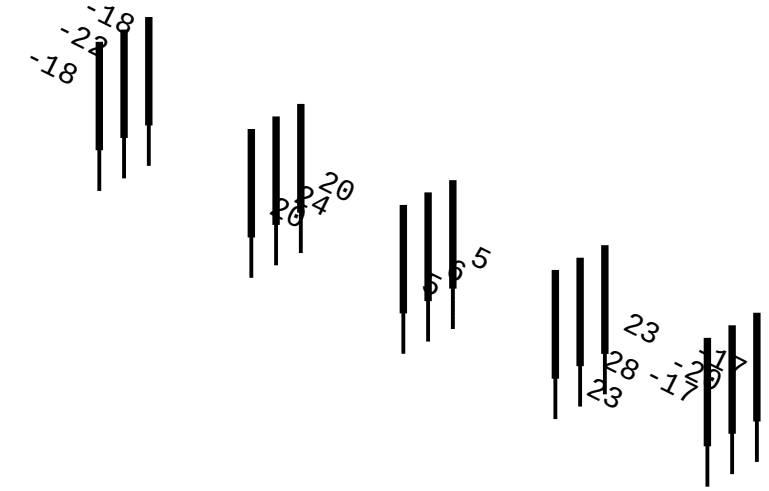
Group: Sipovi
Beam Results: max V3= 86 / min V3= -86 kN

Load 8: to+34



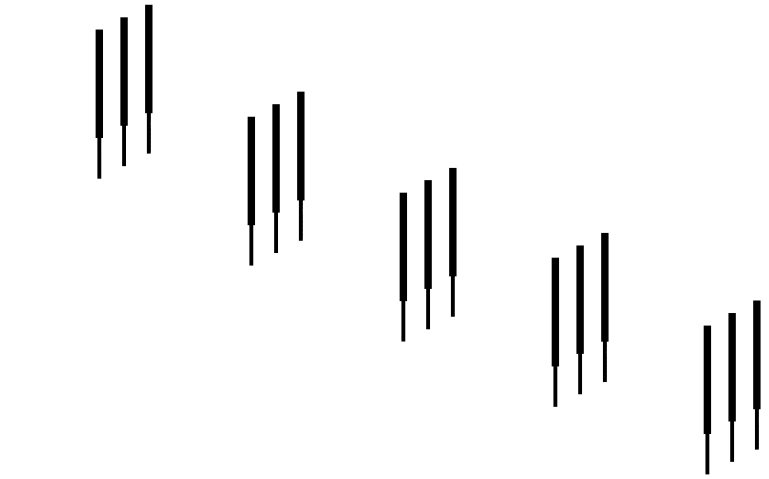
Group: Sipovi
Beam Results: max V2= 121 / min V2= -128 kN

Load 8: to+34



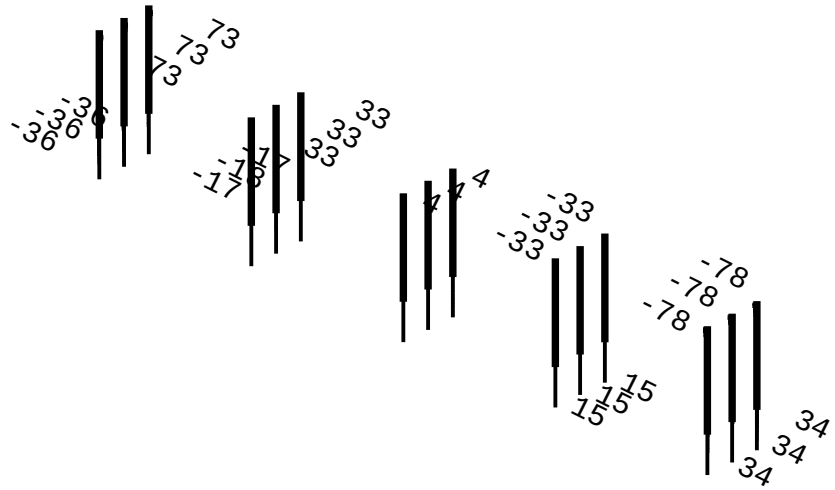
Group: Sipovi
Beam Results: max N1= 37 / min N1= -365 kN

Load 8: to+34



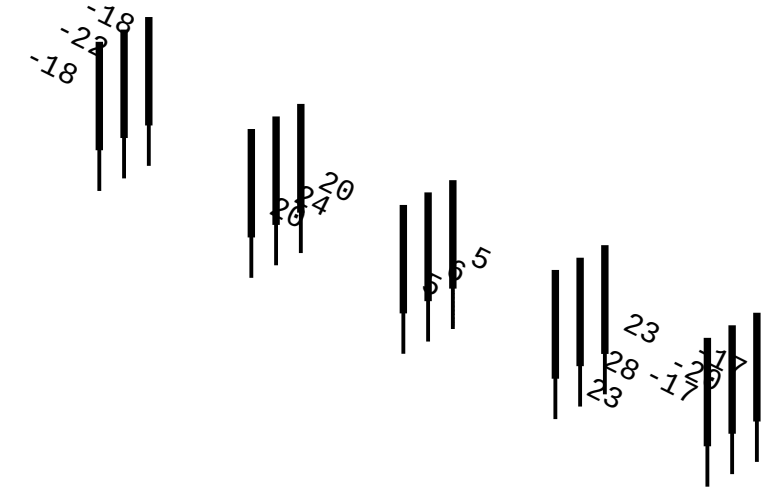
Group: Sipovi
Beam Results: max V3= 86 / min V3= -86 kN

Load 8: to+34



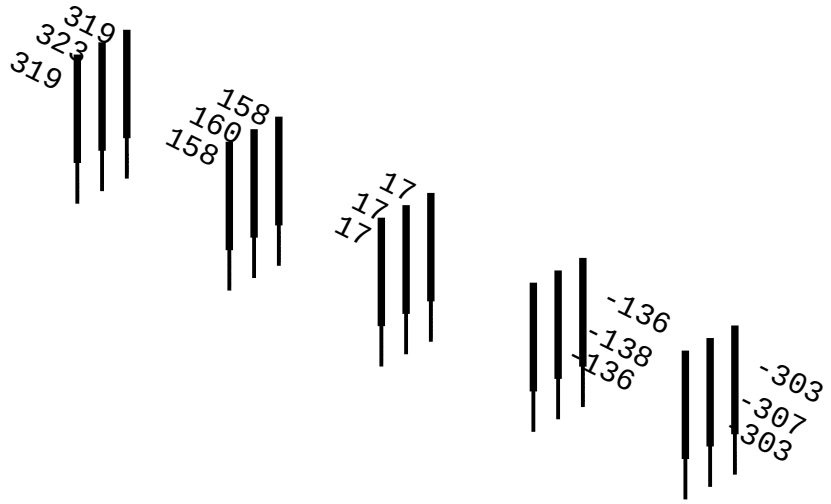
Group: Sipovi
Beam Results: max V2= 121 / min V2= -128 kN

Load 8: to+34



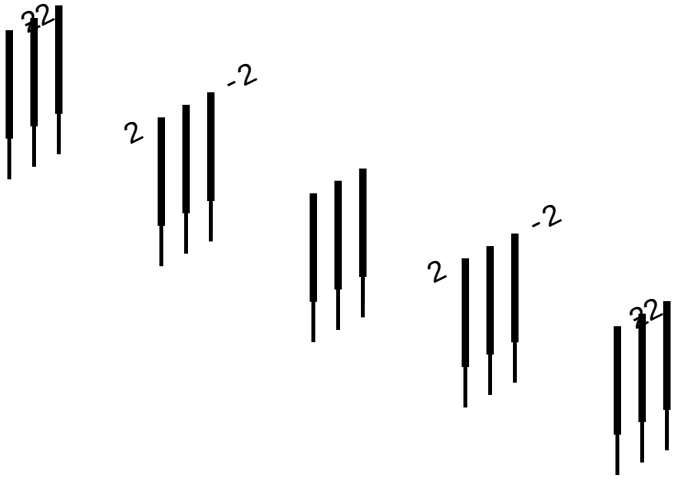
Group: Sipovi
Beam Results: max N1= 37 / min N1= -365 kN

Load 9: to-31



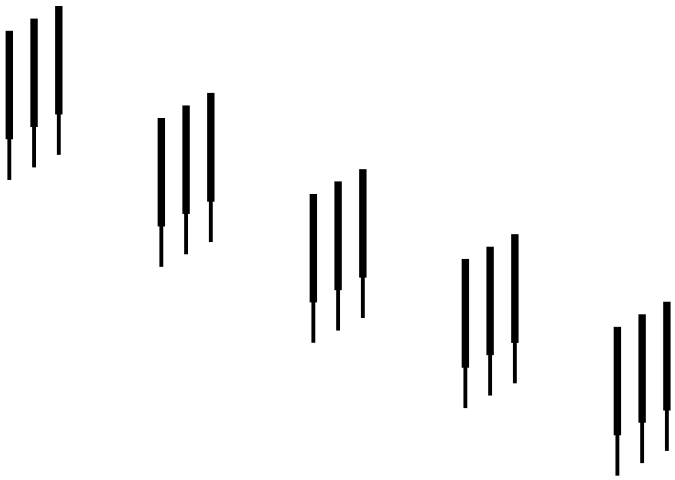
Group: Sipovi
Beam Results: max M3= 994 / min M3= -683 kNm

Load 9: to-31



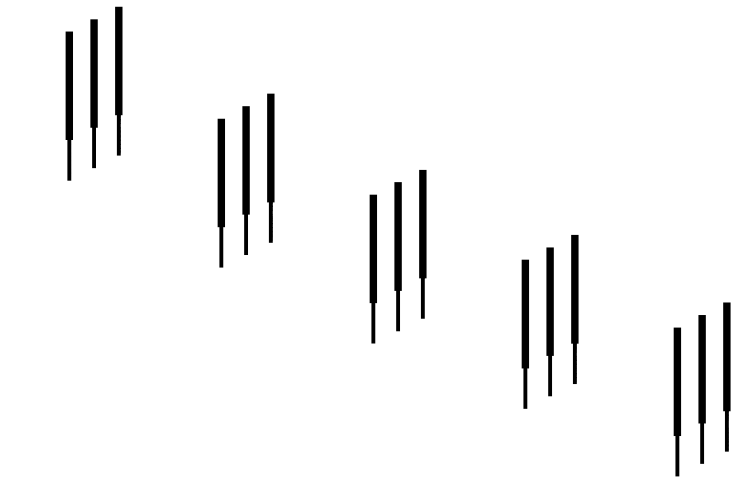
Group: Sipovi
Beam Results: max M2= 140 / min M2= -148 kNm

Load 9: to-31



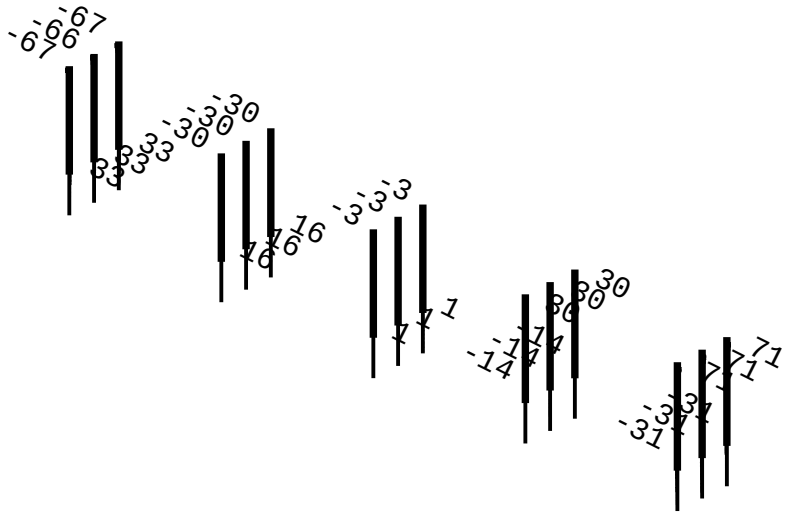
Group: Sipovi
Beam Results: max M1= 201 / min M1= -201 kNm

Load 9: to-31



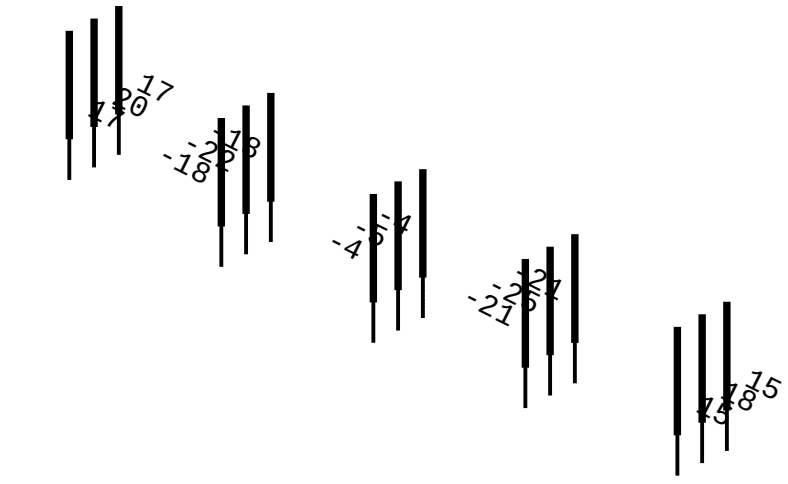
Group: Sipovi
Beam Results: max V3= 78 / min V3= -78 kN

Load 9: to-31



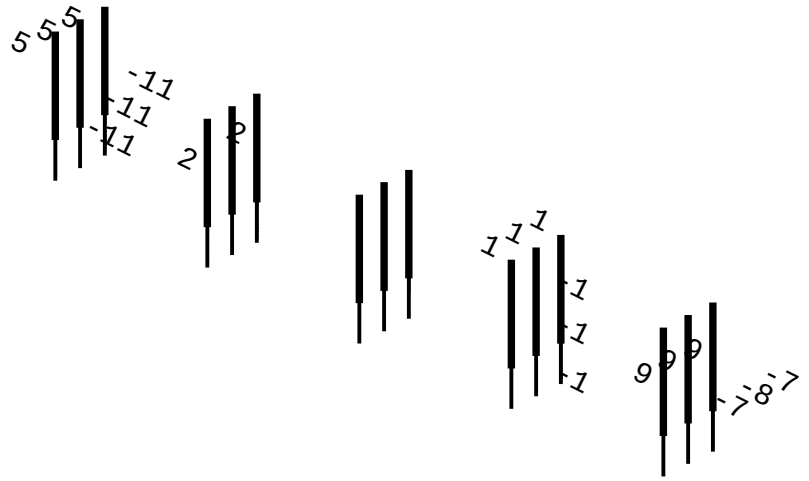
Group: Sipovi
Beam Results: max V2= 117 / min V2= -110 kN

Load 9: to-31



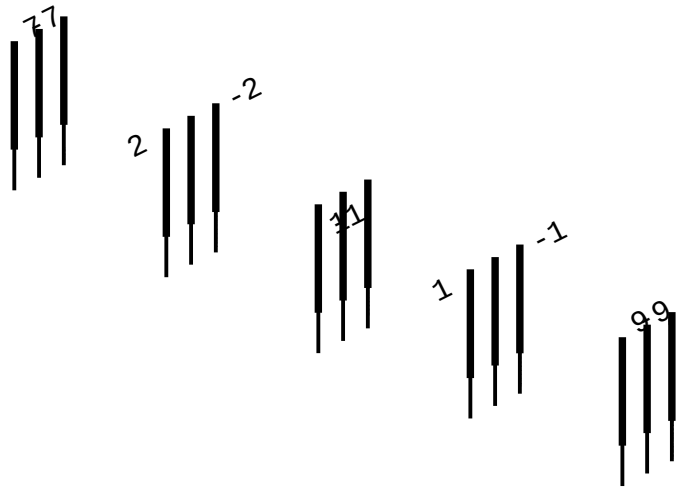
Group: Sipovi
Beam Results: max N1= 333 / min N1= -34 kN

Load 10: dt+12.3



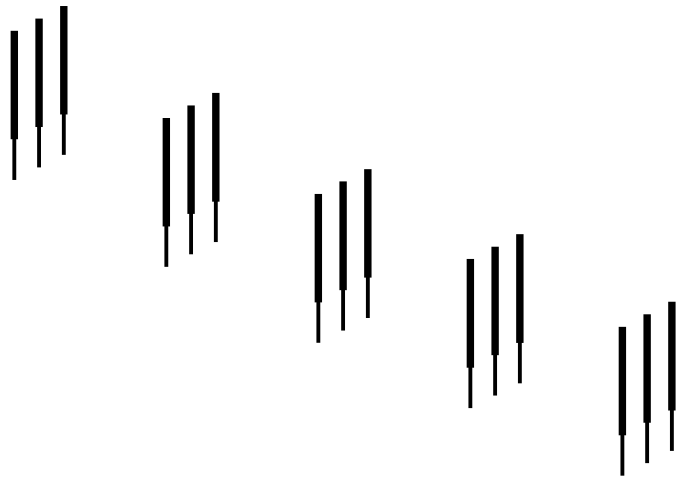
Group: Sipovi
Beam Results: max M3= 3644 / min M3= -140 kNm

Load 10: dt+12.3



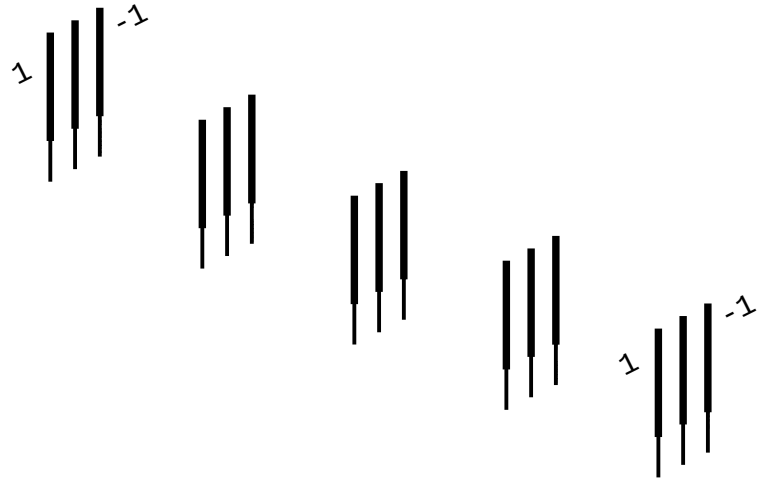
Group: Sipovi
Beam Results: max M2= 20 / min M2= -20 kNm

Load 10: dt+12.3



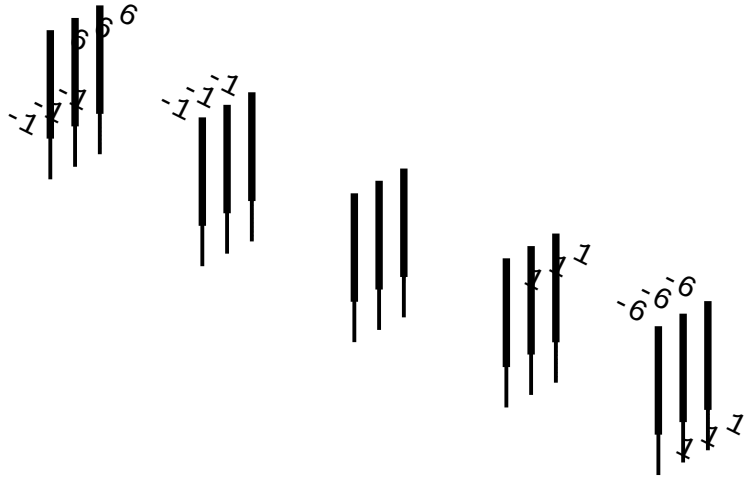
Group: Sipovi
Beam Results: max M1= 7 / min M1= -7 kNm

Load 10: dt+12.3



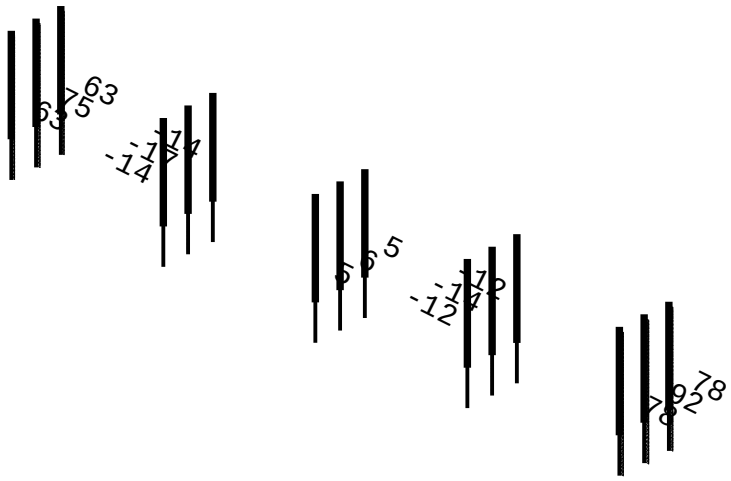
Group: Sipovi
Beam Results: max V3= 6 / min V3= -6 kN

Load 10: dt+12.3



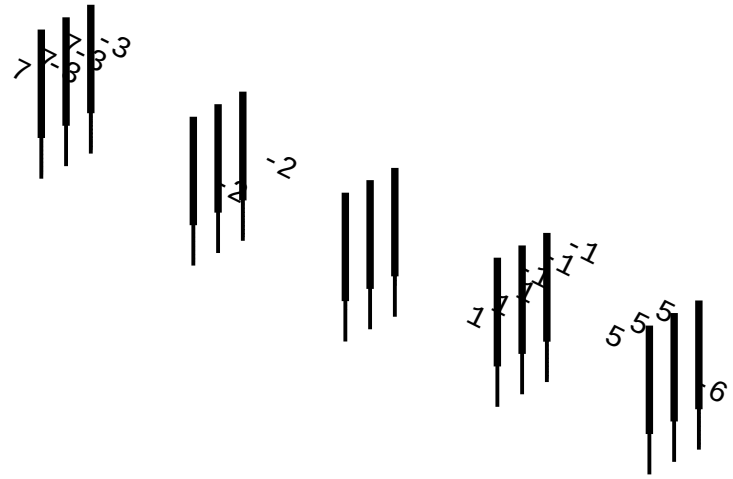
Group: Sipovi
Beam Results: max V2= 219 / min V2= -165 kN

Load 10: dt+12.3



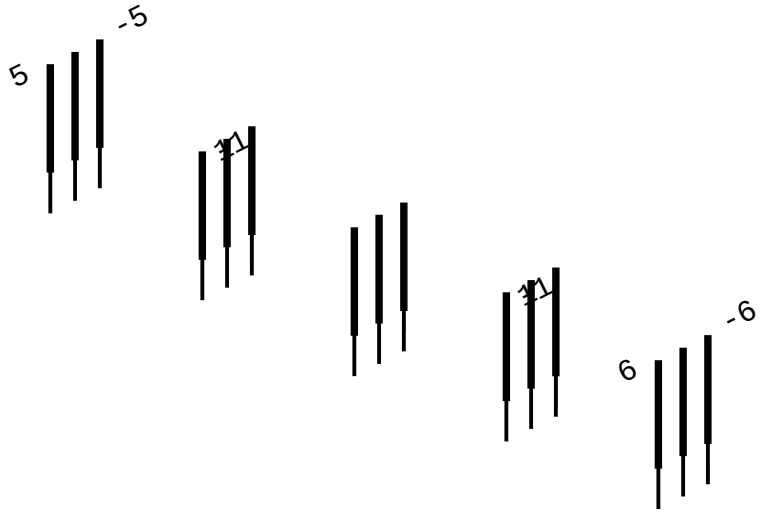
Group: Sipovi
Beam Results: max N1= 124 / min N1= -23 kN

Load 11: dt-8



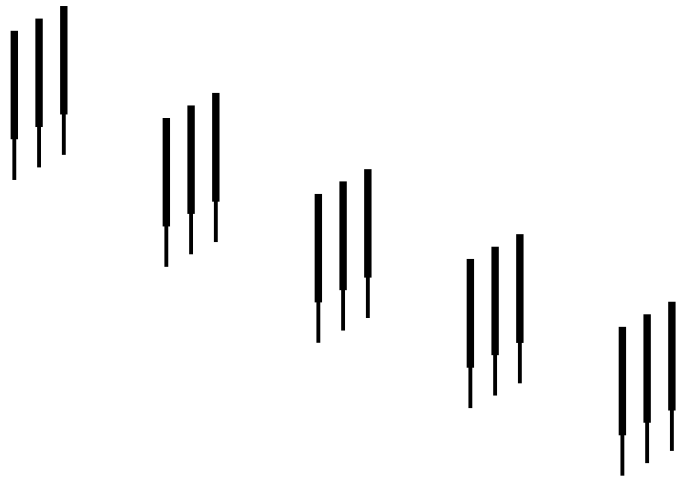
Group: Sipovi
Beam Results: max M3= 91 / min M3= -2370 kNm

Load 11: dt-8



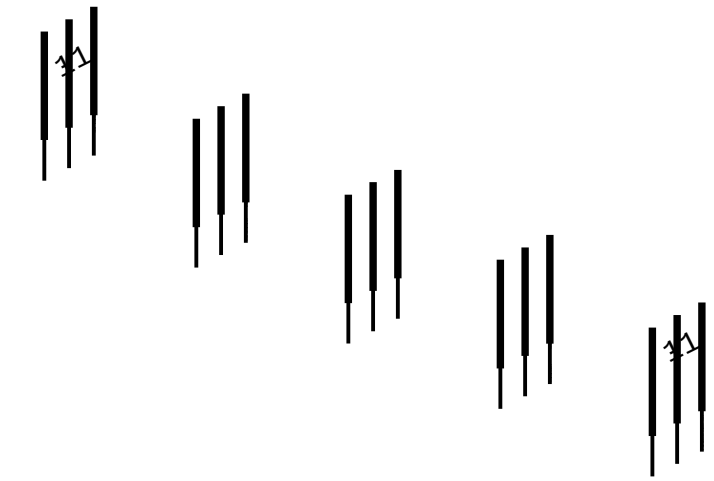
Group: Sipovi
Beam Results: max M2= 13 / min M2= -13 kNm

Load 11: dt-8



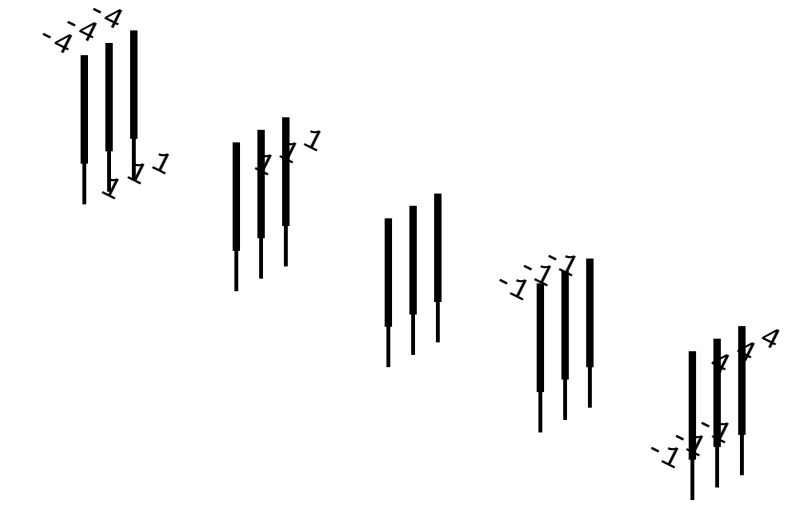
Group: Sipovi
Beam Results: max M1= 5 / min M1= -5 kNm

Load 11: dt-8



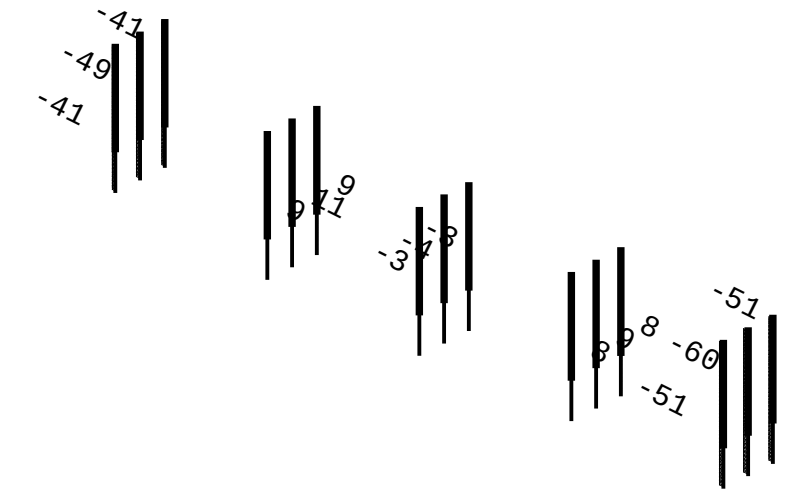
Group: Sipovi
Beam Results: max V3= 4 / min V3= -4 kN

Load 11: dt-8



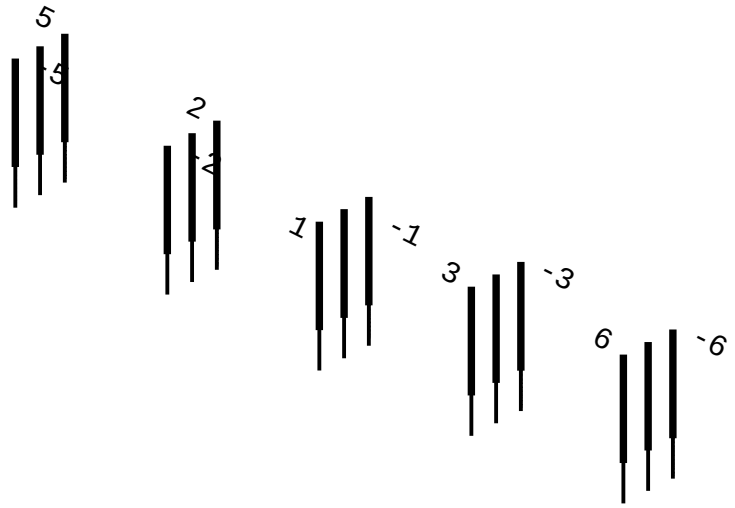
Group: Sipovi
Beam Results: max V2= 107 / min V2= -142 kN

Load 11: dt-8



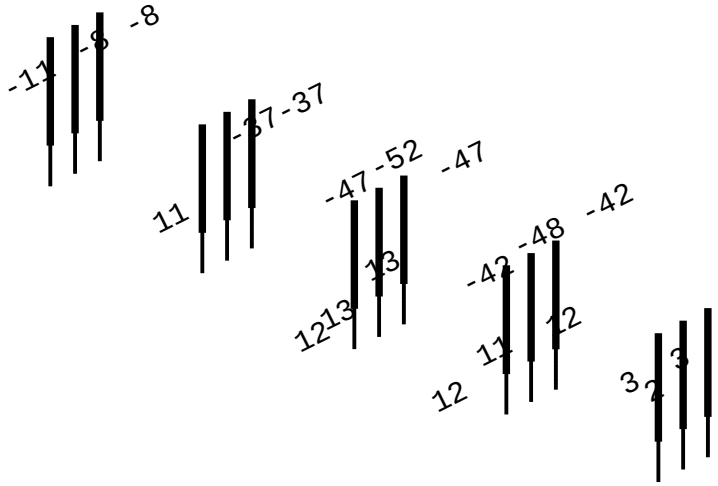
Group: Sipovi
Beam Results: max N1= 15 / min N1= -81 kN

Load 12: Vetar



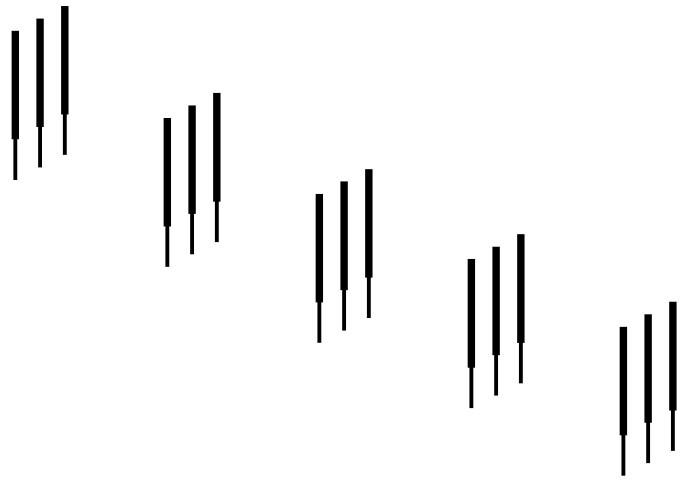
Group: Sipovi
Beam Results: max M3= 217 / min M3= -217 kNm

Load 12: Vetar



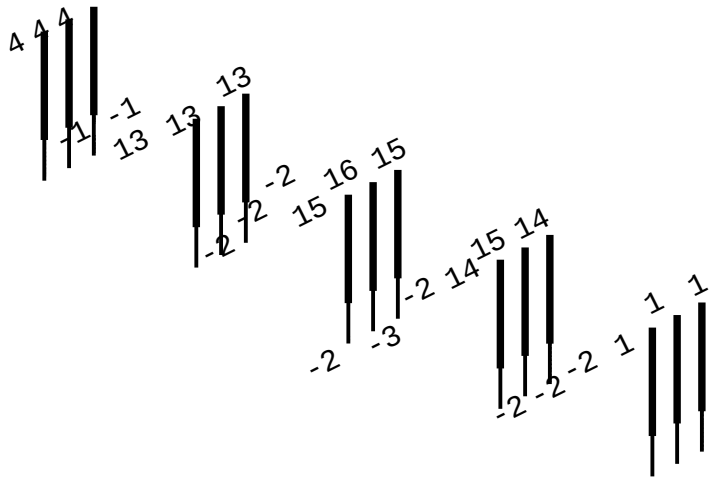
Group: Sipovi
Beam Results: max M2= 255 / min M2= -1400 kNm

Load 12: Vetar



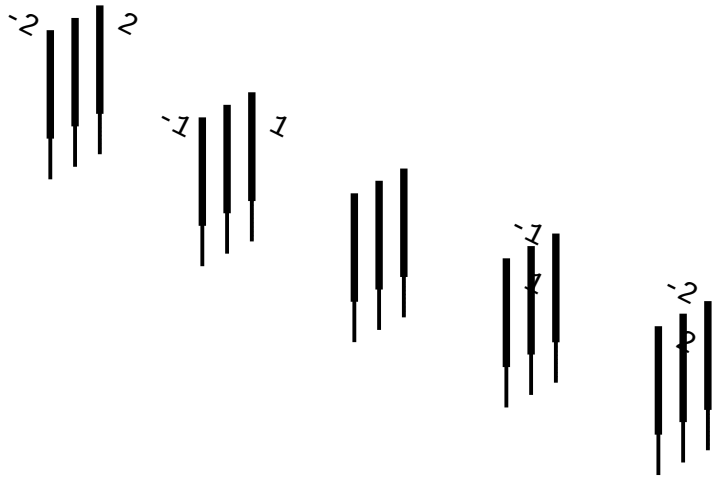
Group: Sipovi
Beam Results: max M1= 227 / min M1= -128 kNm

Load 12: Vetar



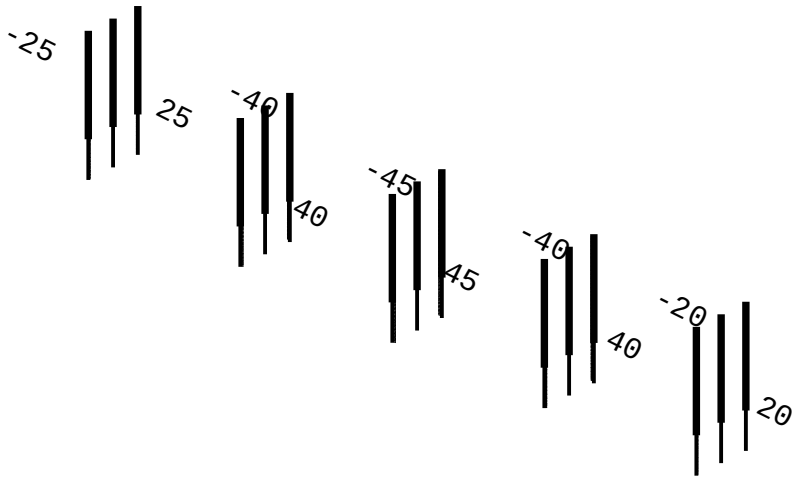
Group: Sipovi
Beam Results: max V3= 73 / min V3= -75 kN

Load 12: Vetar



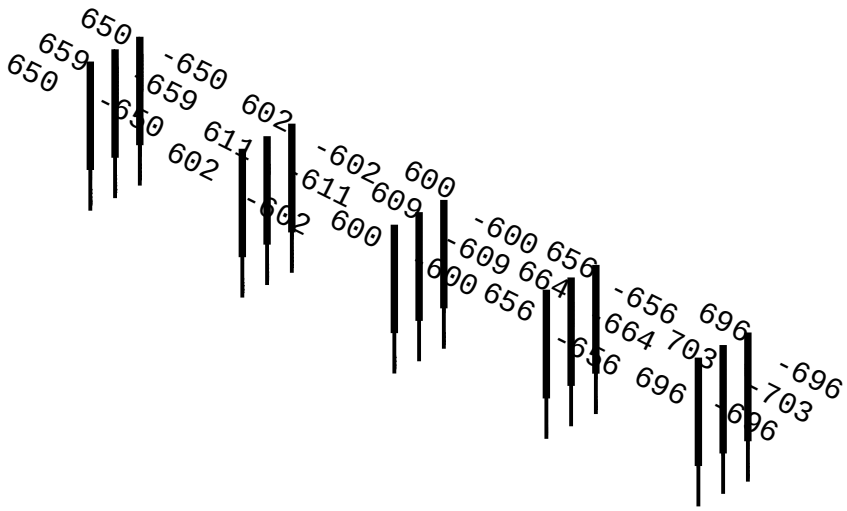
Group: Sipovi
Beam Results: max V2= 143 / min V2= -2 kN

Load 12: Vetar



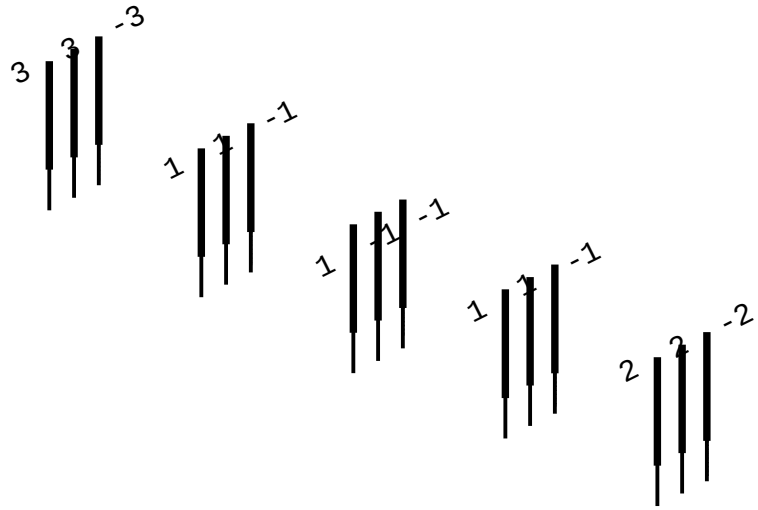
Group: Sipovi
Beam Results: max N1= 99 / min N1= -99 kN

Load 13: Sx



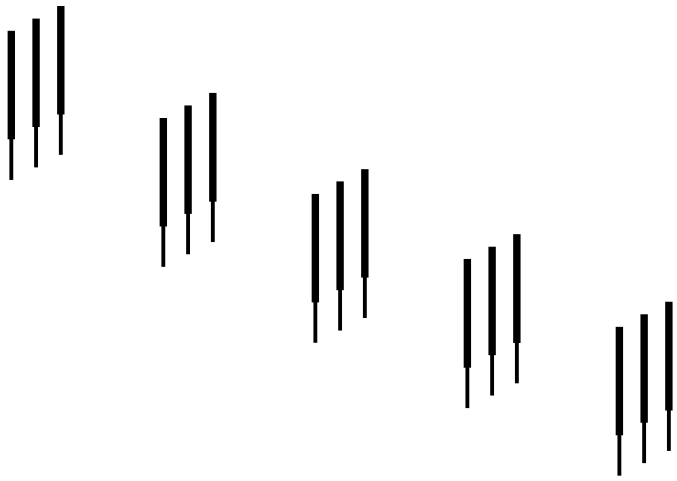
Group: Sipovi
Beam Results: max M3= 1811 / min M3= -1811 kNm

Load 13: Sx



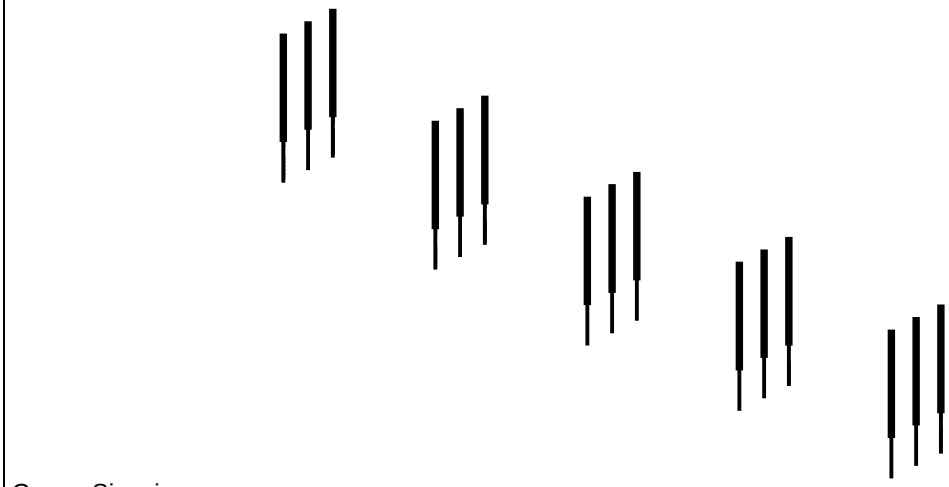
Group: Sipovi
Beam Results: max M2= 353 / min M2= -353 kNm

Load 13: Sx



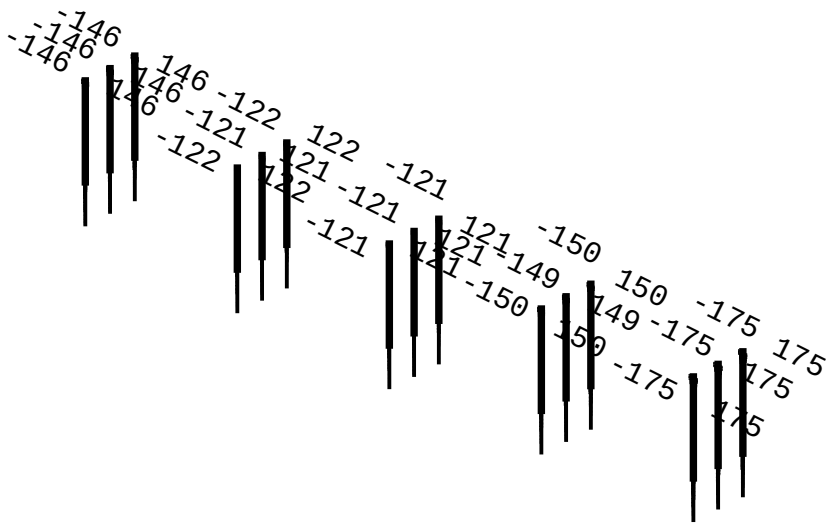
Group: Sipovi
Beam Results: max M1= 396 / min M1= -396 kNm

Load 13: Sx



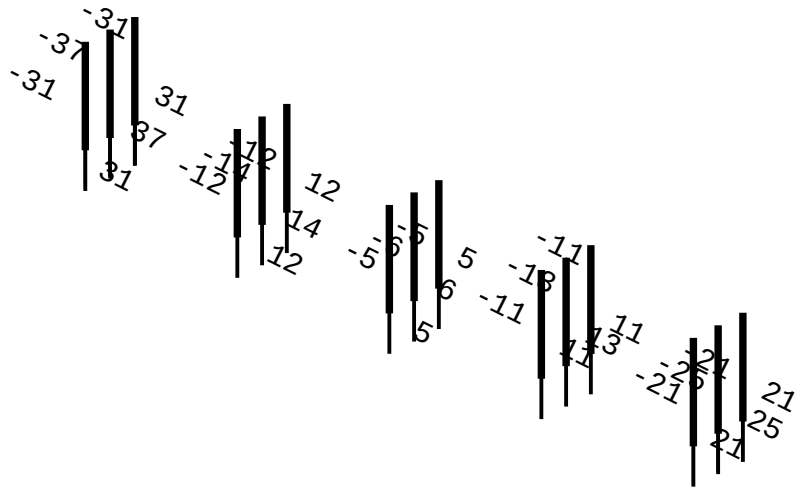
Group: Sipovi
Beam Results: max V3= 186 / min V3= -186 kN

Load 13: Sx



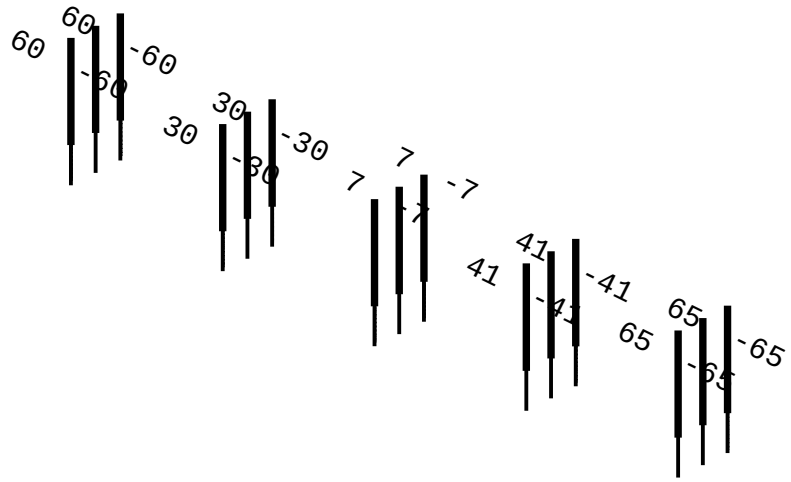
Group: Sipovi
Beam Results: max V2= 272 / min V2= -272 kN

Load 13: Sx



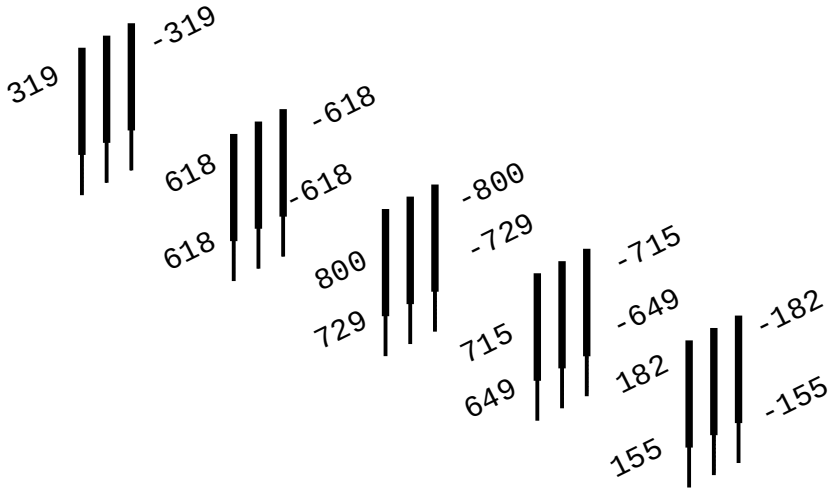
Group: Sipovi
Beam Results: max N1= 184 / min N1= -184 kN

Load 14: Sy



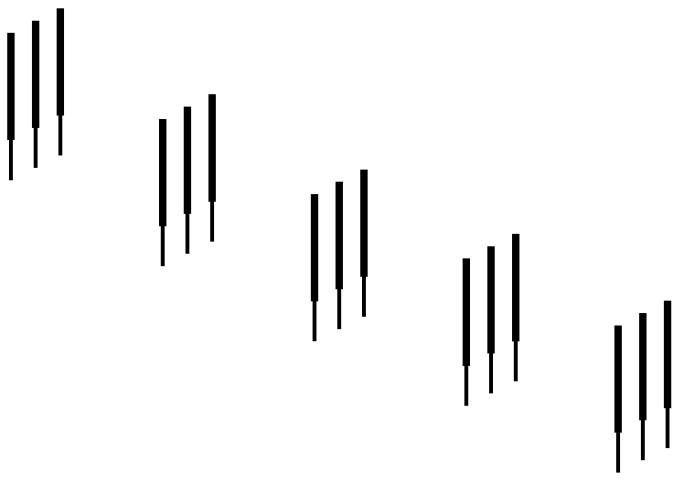
Group: Sipovi
Beam Results: max M3= 2410 / min M3= -2410 kNm

Load 14: Sy



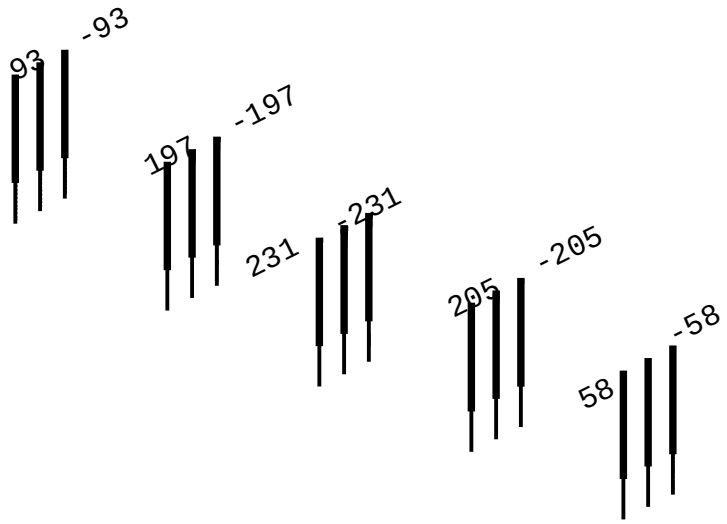
Group: Sipovi
Beam Results: max M2= 16706 / min M2= -16706 kNm

Load 14: Sy



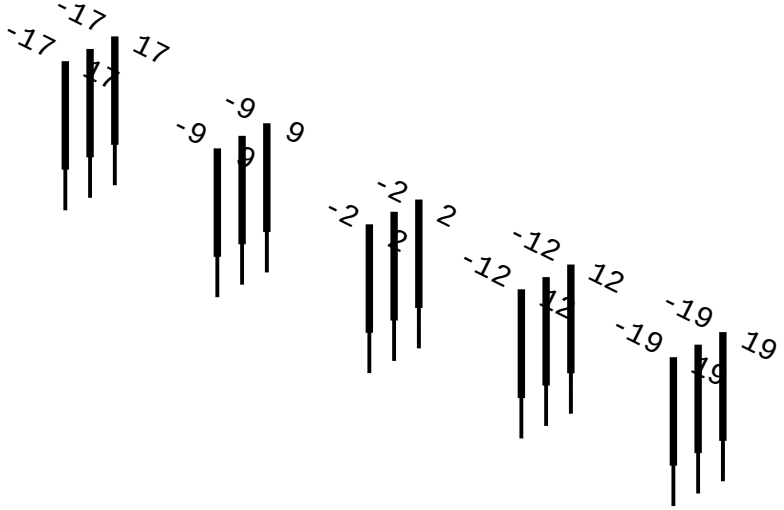
Group: Sipovi
Beam Results: max M1= 1883 / min M1= -1883 kNm

Load 14: Sy



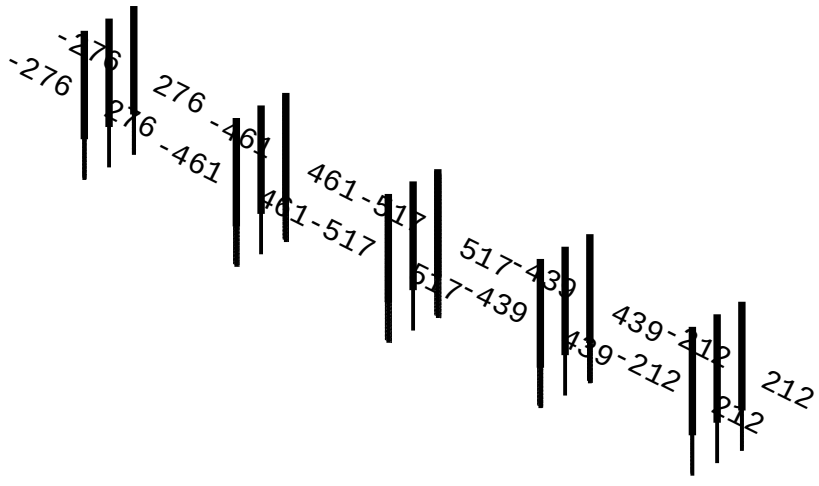
Group: Sipovi
Beam Results: max V3= 480 / min V3= -480 kN

Load 14: Sy



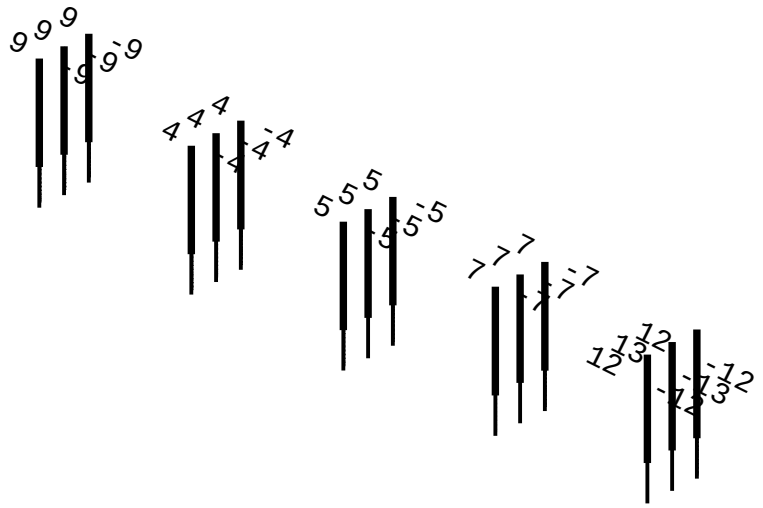
Group: Sipovi
Beam Results: max V2= 1652 / min V2= -1652 kN

Load 14: Sy



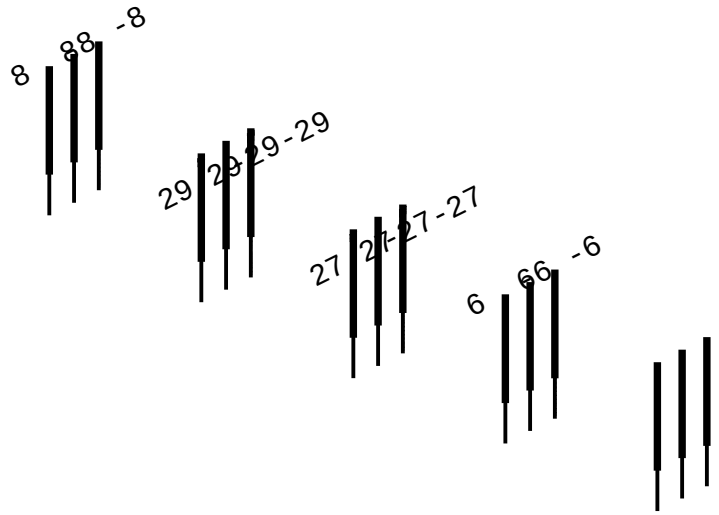
Group: Sipovi
Beam Results: max N1= 1136 / min N1= -1136 kN

Load 15: Sz



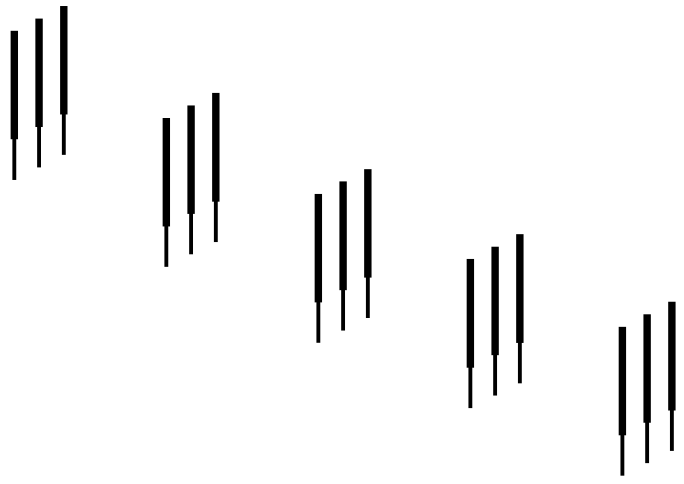
Group: Sipovi
Beam Results: max M3= 456 / min M3= -456 kNm

Load 15: Sz



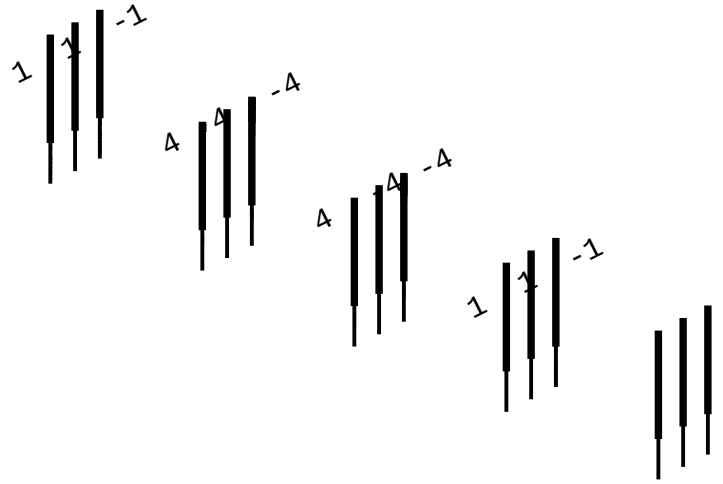
Group: Sipovi
Beam Results: max M2= 54 / min M2= -54 kNm

Load 15: Sz



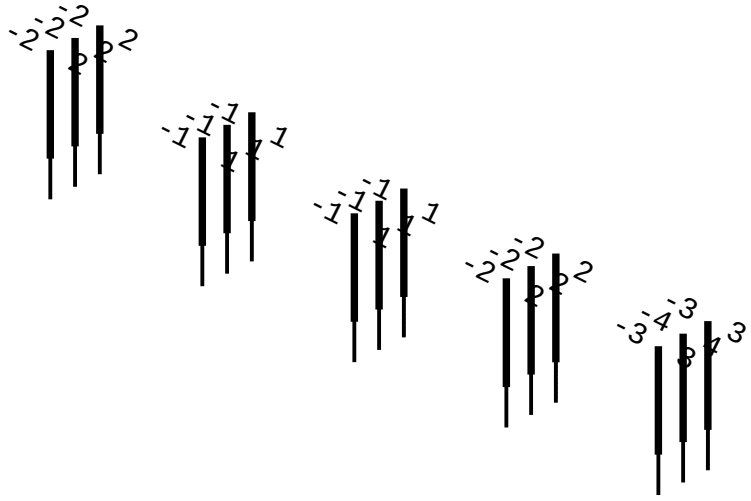
Group: Sipovi
Beam Results: max M1= 12 / min M1= -12 kNm

Load 15: Sz



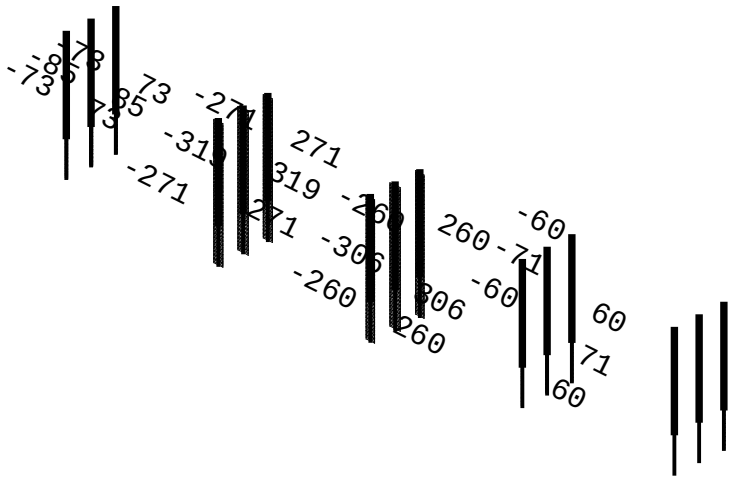
Group: Sipovi
Beam Results: max V3= 8 / min V3= -8 kN

Load 15: Sz



Group: Sipovi
Beam Results: max V2= 257 / min V2= -257 kN

Load 15: Sz

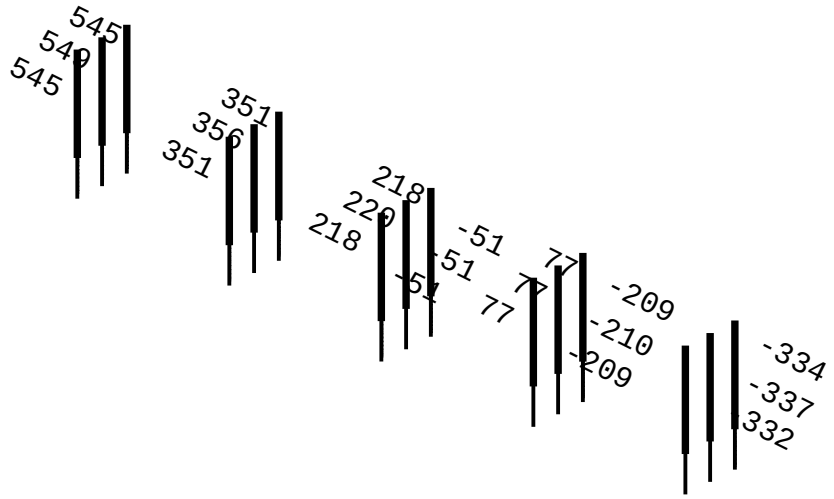


Group: Sipovi
Beam Results: max N1= 375 / min N1= -375 kN

4.6.8.2 **Димензионисање /** Reinforcement design

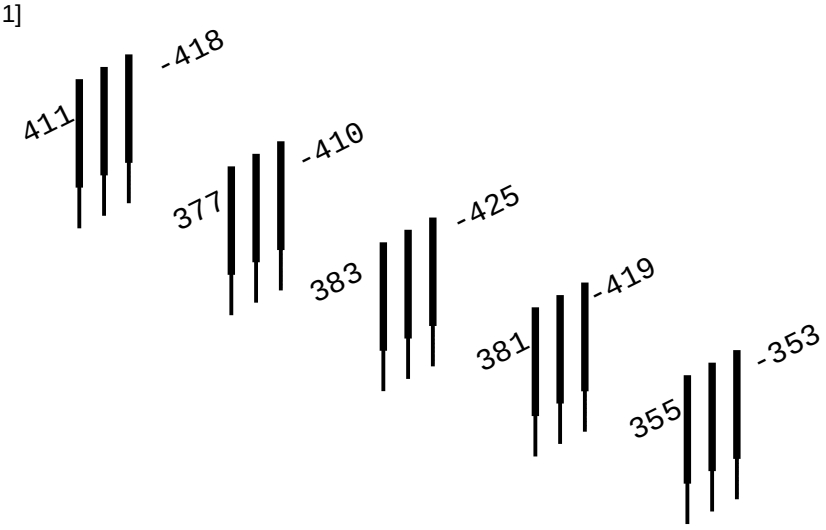
Comb 1

Load 361: [Comb 1]



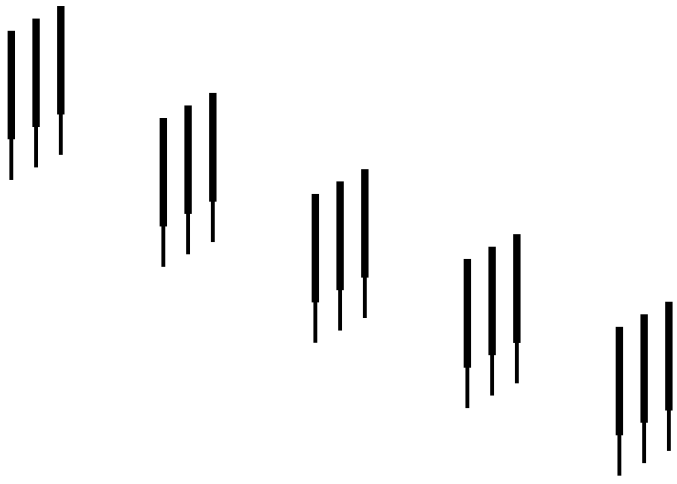
Group: Sipovi
Beam Results: max M3= 19882 / min M3= -23300 kNm

Load 361: [Comb 1]



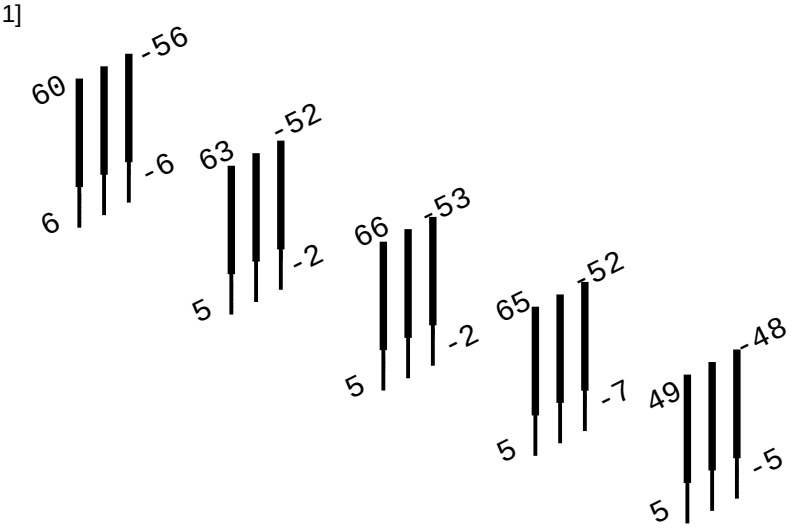
Group: Sipovi
Beam Results: max M2= 1024 / min M2= -1260 kNm

Load 361: [Comb 1]



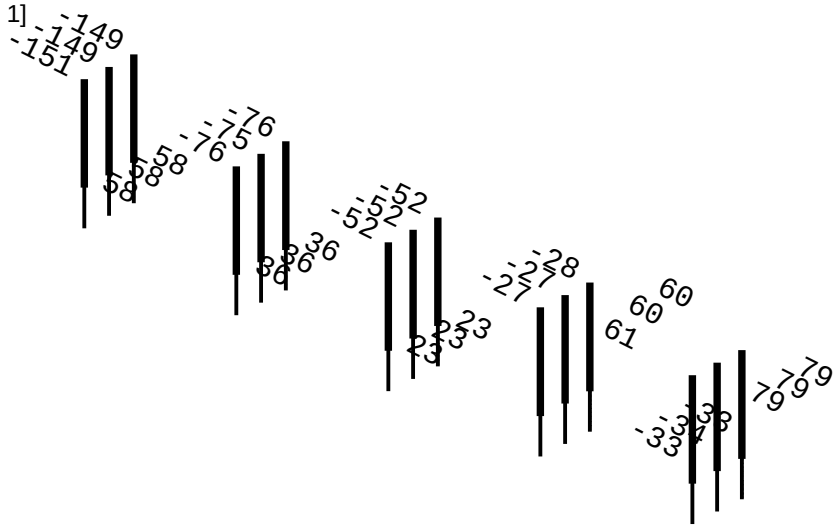
Group: Sipovi
Beam Results: max M1= 313 / min M1= -318 kNm

Load 361: [Comb 1]



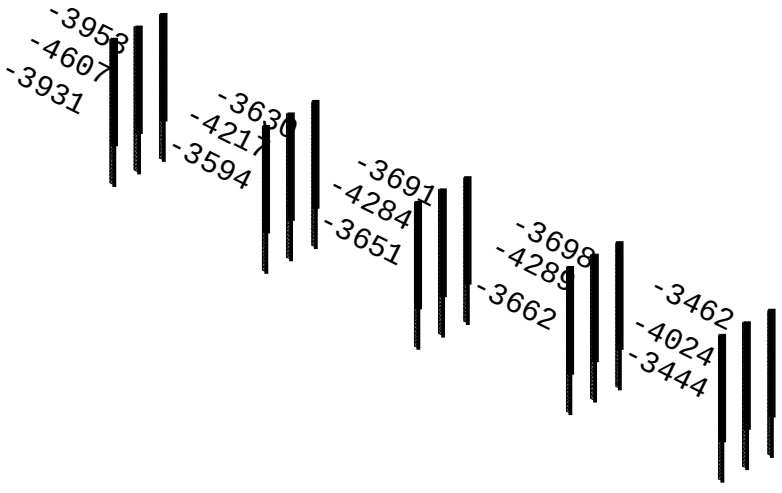
Group: Sipovi
Beam Results: max V3= 164 / min V3= -163 kN

Load 361: [Comb 1]



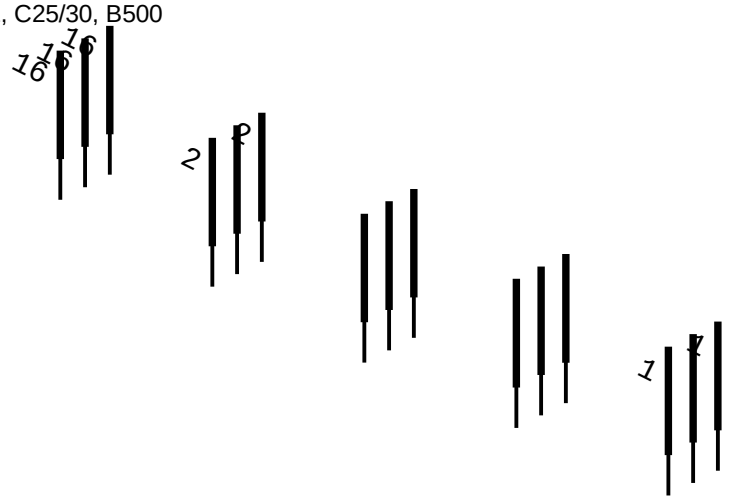
Group: Sipovi
Beam Results: max V2= 6393 / min V2= -5651 kN

Load 361: [Comb 1]



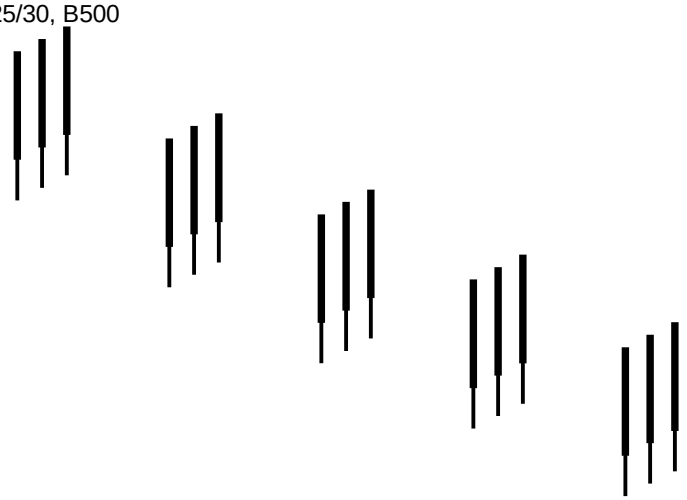
Group: Sipovi
Beam Results: max N1= 398 / min N1= -5787 kN

Governing load: [Comb 1]
SRPS EN 1992-1-1, C25/30, B500



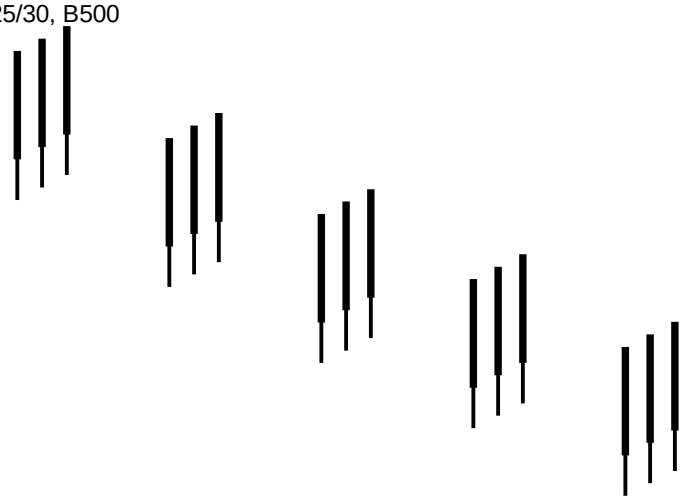
Group: Sipovi
Beam reinforcement: Aa2/Aa1

Governing load: [Comb 1]
SRPS EN 1992-1-1, C25/30, B500



Group: Sipovi
Beam reinforcement: Aa3/Aa4

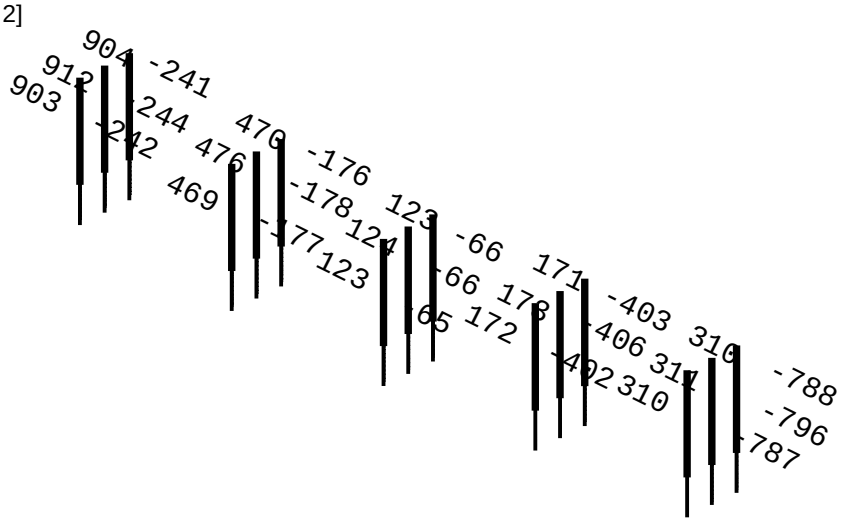
Governing load: [Comb 1]
SRPS EN 1992-1-1, C25/30, B500



Group: Sipovi
Beam reinforcement: Aa,br

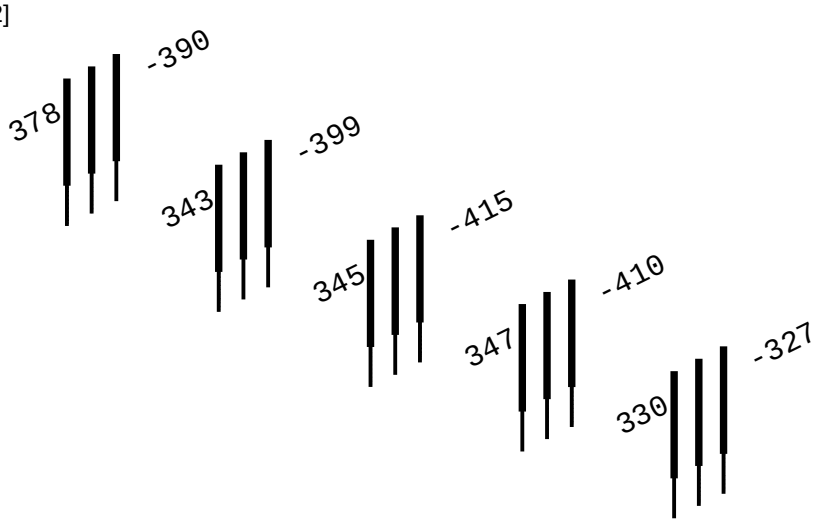
Comb 2

Load 362: [Comb 2]



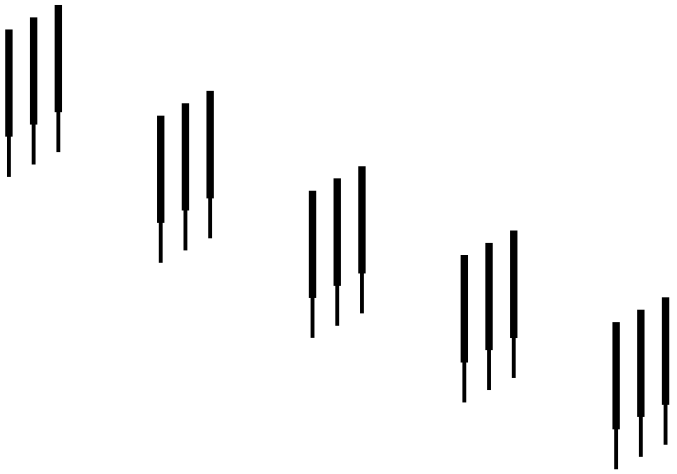
Group: Sipovi
Beam Results: max M3= 19605 / min M3= -24575 kNm

Load 362: [Comb 2]



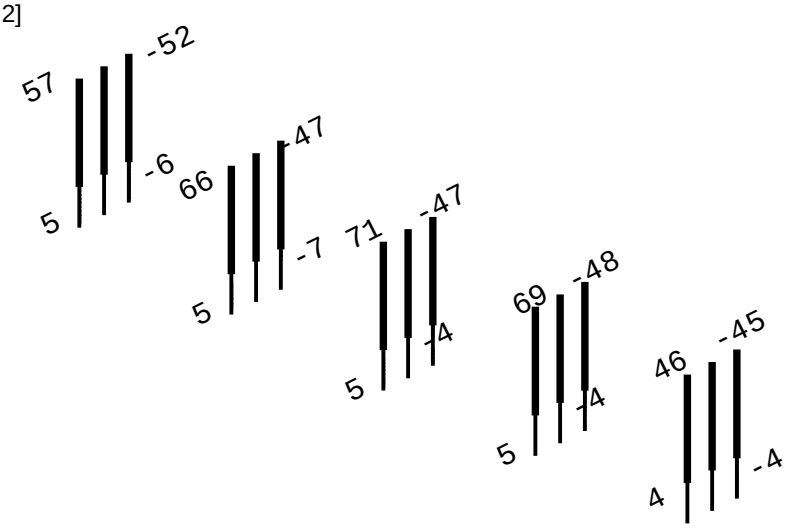
Group: Sipovi
Beam Results: max M2= 1093 / min M2= -2100 kNm

Load 362: [Comb 2]



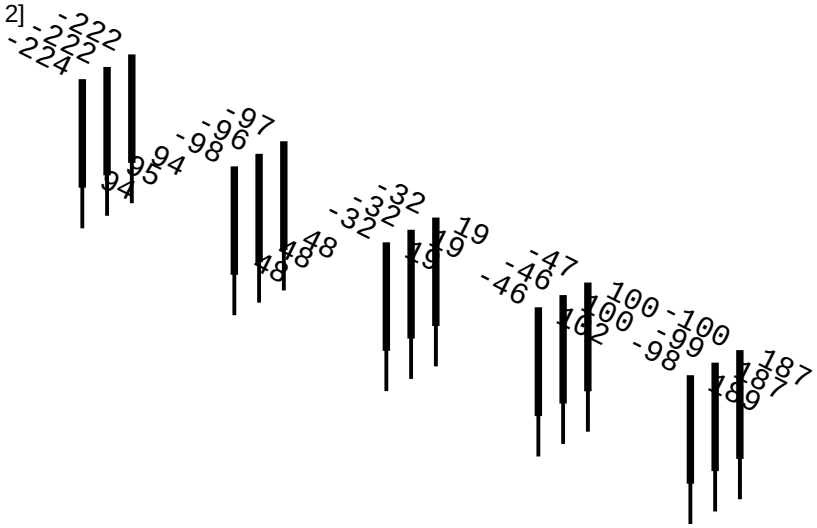
Group: Sipovi
Beam Results: max M1= 542 / min M1= -550 kNm

Load 362: [Comb 2]



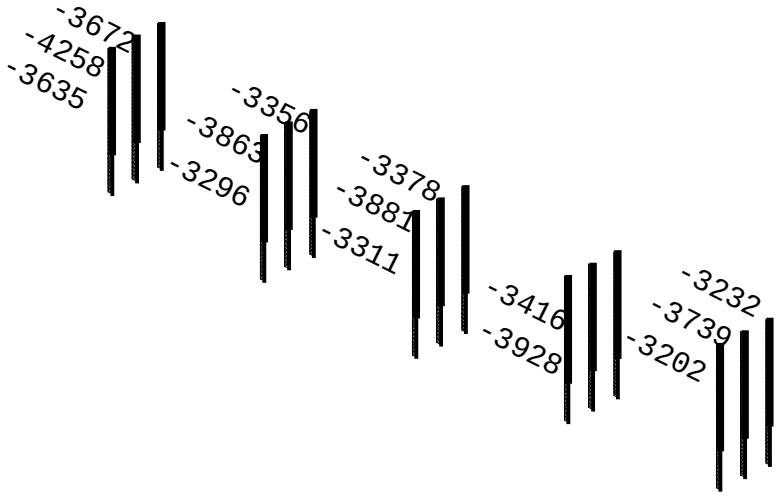
Group: Sipovi
Beam Results: max V3= 246 / min V3= -244 kN

Load 362: [Comb 2]



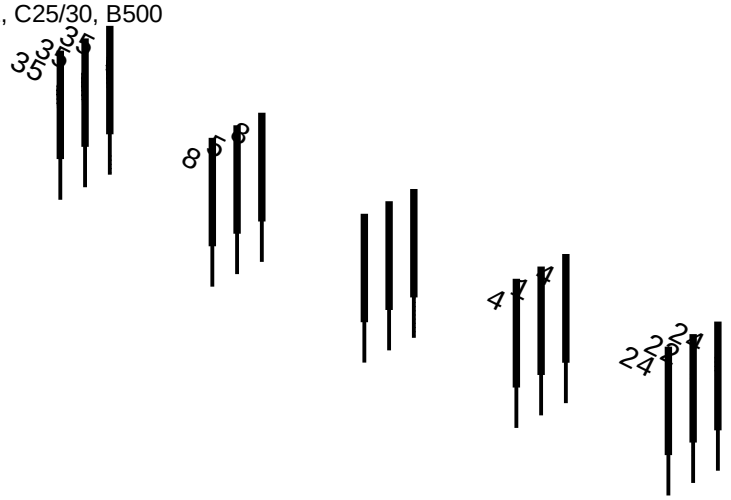
Group: Sipovi
Beam Results: max V2= 5763 / min V2= -5069 kN

Load 362: [Comb 2]



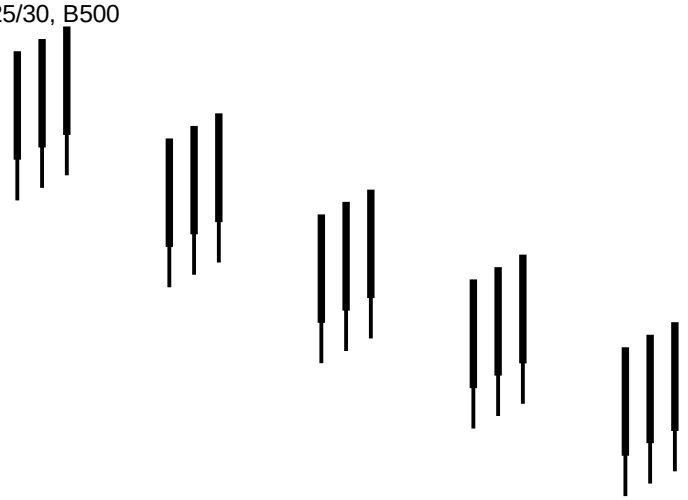
Group: Sipovi
Beam Results: max N1= 878 / min N1= -5354 kN

Governing load: [Comb 2]
SRPS EN 1992-1-1, C25/30, B500



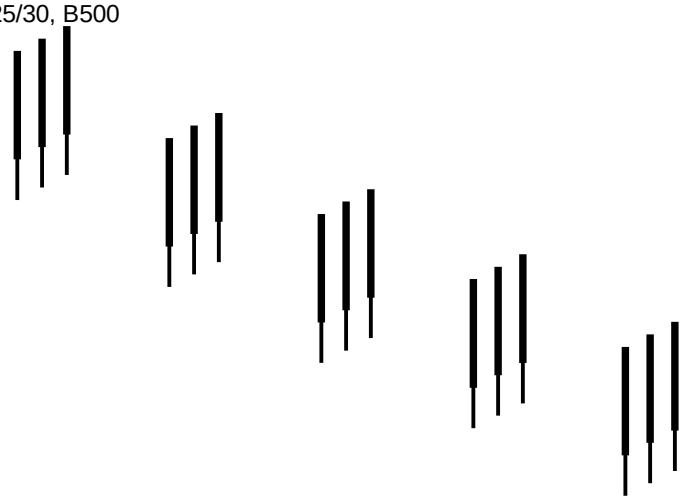
Group: Sipovi
Beam reinforcement: Aa2/Aa1

Governing load: [Comb 2]
SRPS EN 1992-1-1, C25/30, B500



Group: Sipovi
Beam reinforcement: Aa3/Aa4

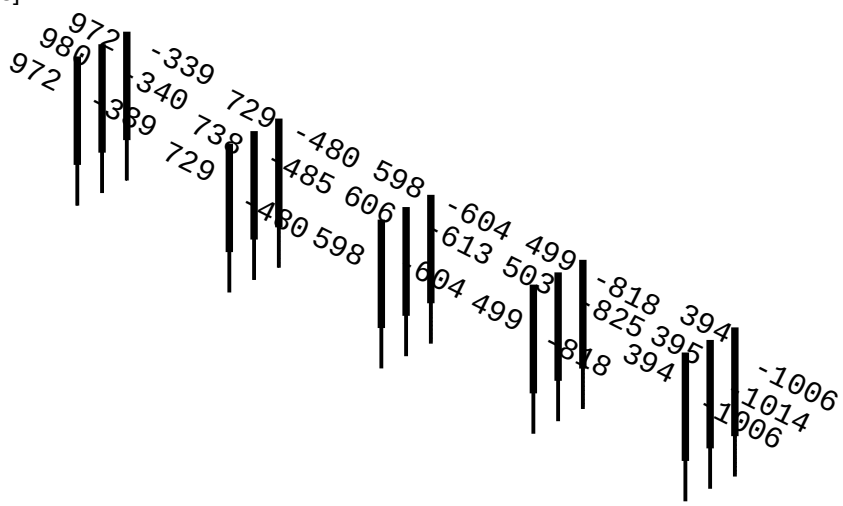
Governing load: [Comb 2]
SRPS EN 1992-1-1, C25/30, B500



Group: Sipovi
Beam reinforcement: Aa,br

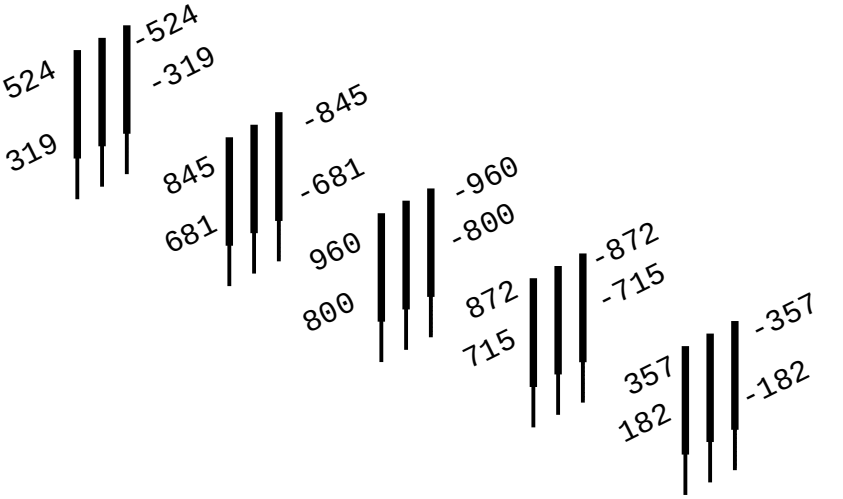
Comb 3

Load 363: [Comb 3]



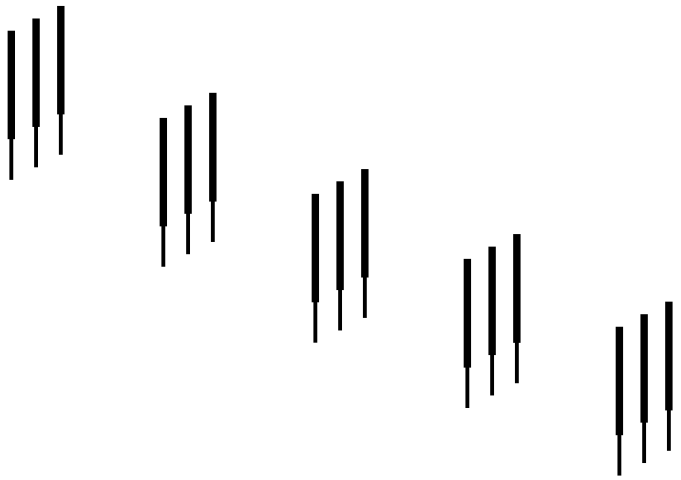
Group: Sipovi
Beam Results: max M3= 9579 / min M3= -14060 kNm

Load 363: [Comb 3]



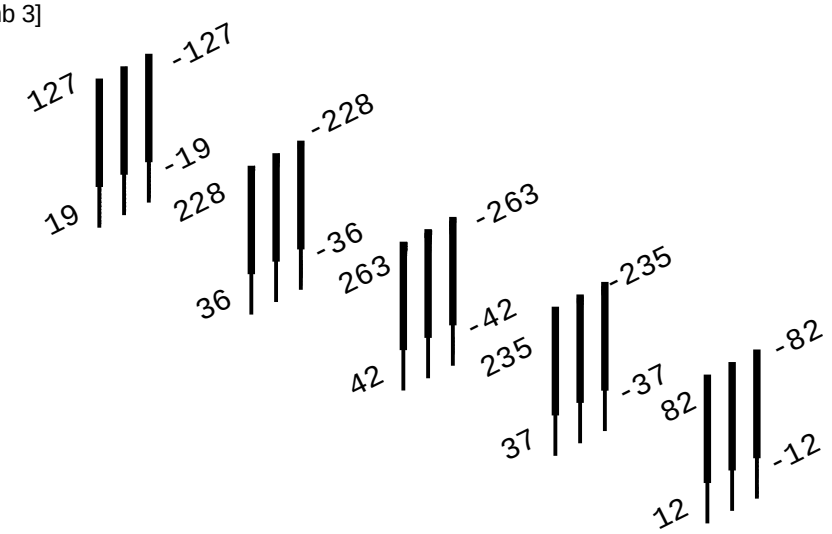
Group: Sipovi
Beam Results: max M2= 16706 / min M2= -16706 kNm

Load 363: [Comb 3]



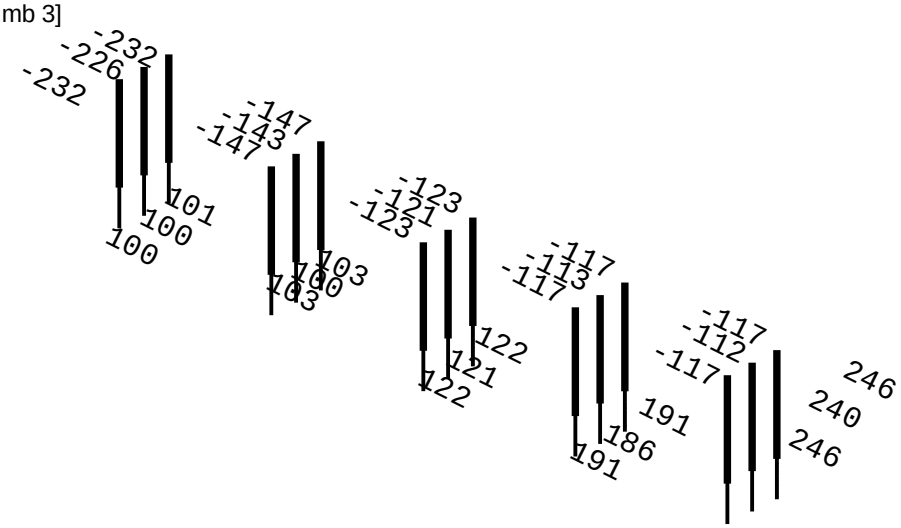
Group: Sipovi
Beam Results: max M1= 1883 / min M1= -1883 kNm

Load 363: [Comb 3]



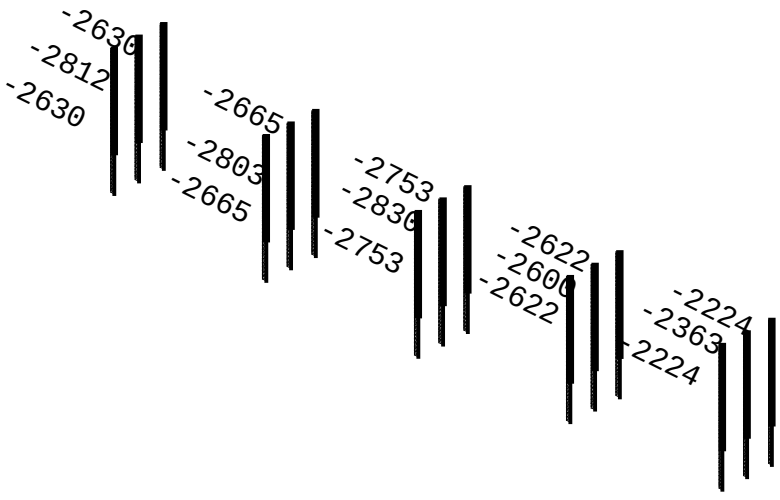
Group: Sipovi
Beam Results: max V3= 480 / min V3= -480 kN

Load 363: [Comb 3]



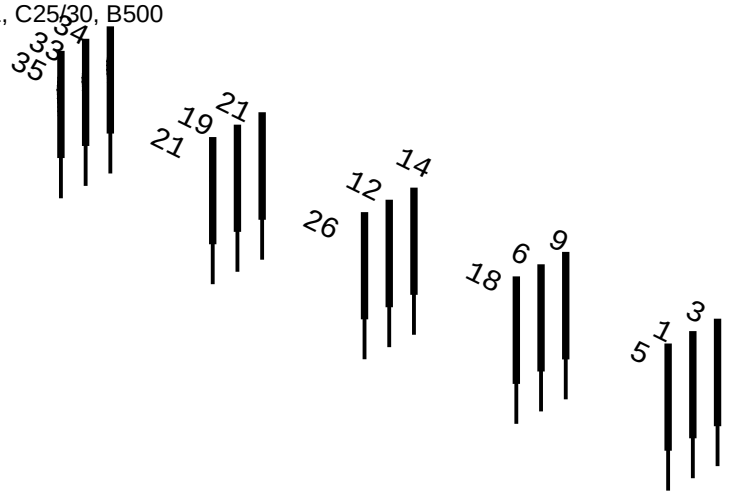
Group: Sipovi
Beam Results: max V2= 3337 / min V2= -2987 kN

Load 363: [Comb 3]



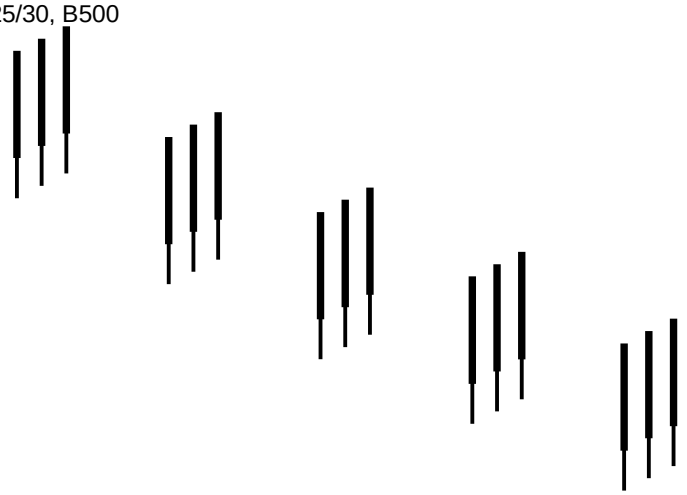
Group: Sipovi
Beam Results: max N1= 493 / min N1= -4291 kN

Governing load: [Comb 3]
SRPS EN 1992-1-1, C25/30, B500



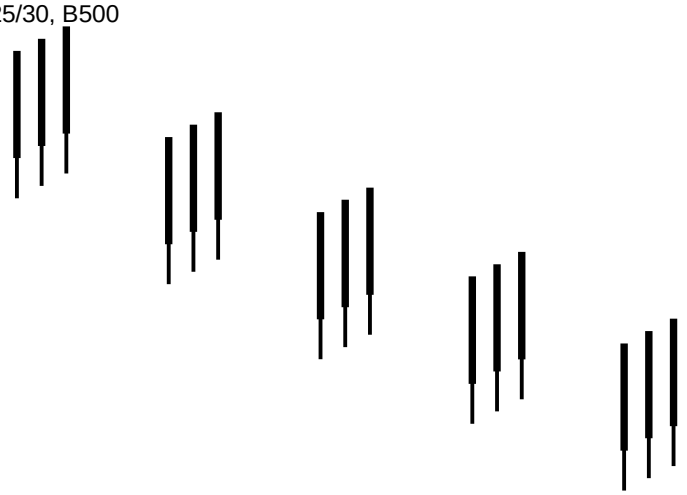
Group: Sipovi
Beam reinforcement: Aa2/Aa1

Governing load: [Comb 3]
SRPS EN 1992-1-1, C25/30, B500



Group: Sipovi
Beam reinforcement: Aa3/Aa4

Governing load: [Comb 3]
SRPS EN 1992-1-1, C25/30, B500



Group: Sipovi
Beam reinforcement: Aa,br

Потребна арматура / required reinforcement

Вертикална арматура / Vertical reinforcement

Aa =35 cm2

Смичућа арматура / Shear reinforcement

Aa = 0 cm2/m

Minimalna armatura / Minimum reinforcement

Φ120 cm → Ab = 11304 cm2

Aa,min = 0.0025xAc = 0.0025x11304 = 28.26 cm2

Usvojena armatura / provided reinforcement :

Podužna armatura / Longitudinal reinforcement

18Φ20/20 (Aa = 56.52 cm2) **Вертикална арматура** / Vertical reinforcement

Φ12/15 (Aa = 7.54 cm2/m) → **узенгије** / stirrups

Maksimalna sila u šipu / Maximal axial force

	ULS	SLS
	Nmax	Nmax
S8	4607	3409
S9	4217	3125
S10	4284	3176
S11	4289	3182
S12	4024	2974

1 SEISMICITY OF THE TERRAIN

According to (SRPS EN 1998-2), the input parameters for seismic analysis are derived from the condition that the object, with an average service life of 50 years, does not collapse, which corresponds to seismic action with a probability of exceeding 10% over a period of 50 years. This earthquake has a return period of events of T_{NCR} = 475 years.

The second condition is that limited damage can occur only as a consequence of an earthquake, for probability which can be exceeded by up to 10% in a period of 10 years or an earthquake that has an average return period of 95 years.

To estimate the seismicity of the terrain, the map of the Republic Seismological Institute was used - the map of seismic hazard of the Republic of Serbia, which is expressed in degrees of macroseismic intensity (MCS) and the map of seismic hazard of the Republic of Serbia expressed in units of horizontal acceleration (g).

The subject location, on oleates of macroseismic intensity of earthquakes, is located in zone V-VI° MCS for a return period of 95 years, and in zone VI-VII° MCS for a return period of 475 years. The value of the horizontal acceleration of soil oscillation (a_{gr}) is 0.03g for the return period of 95 years, and 0.05g for the return period of 475 years.

According to the soil typification (SRPS EN 1998-1), the soil is characterized as a soil of "C" type - deposits of dense or medium-dense sand, gravel or solid clay (we would recommend that the soil is characterized as “E” type soil - alluvial soil with 5-20 m thickness that is characterized ether as C or D with stiffer or firmer soil underneath).

According to the typification of the category of the object (SRPS EN 1998-2), the overpass belongs to the category: bridge of class II importance.

According to Eurocode 8, the design soil acceleration a_g is represented by the product of the factor of significance of the object γ_I and the reference maximum soil acceleration a_{gr}. As the significance factor for the bridge of class II importance γ_I is 1.0, the value of the design acceleration a_g is 0.29 m/s^2 for the first condition and 0.49 m/s^2 for the second condition.

Type I elastic response spectrum is recommended, and the periods are defined in **Table 1**.

Table 1. *Values of period parameters wich describing the recommended type I elastic response spectrum*

Type of soil	S	T_B	T_C	T_D
C	1.15	0.20 s	0.60 s	2.0 s
E	1.40	0.15 s	0.50 s	2.0 s

The coefficient of seismic intensity K_s is equal to 0.025.

2 REVIEW OF COMPLETED INVESTIGATION WORKS

2.1 FIELD INVESTIGATION WORKS

An overview of the basic identification data of archival and newly constructed exploration boreholes and performed static penetration experiments, drilling depth and groundwater level is shown in **Table 2**.

Table 2. *Overview of basic identification data of exploration wells*

Serial number	Label	Coordinates			Depth (m)	GWL (m)	Contractor, year
		Y	*X*	*Z*			
1.	CRDC Bn-35	7 396 585	5 035 710	80.14	25.0	2.2	CPL, 2020.
2.	CRDC Bn-36	7 396 624	5 035 695	80.31	26.0	3.7	CPL, 2020.
3.	CRDC Bn-37	7 396 668	5 035 692	82.45	27.0	4.6	CPL, 2020.
4.	CRDC Bn-38	7 396 712	5 035 686	82.21	27.0	6.9	CPL, 2020.
5.	CRDC Bn-39	7 396 785	5 035 682	83.56	27.0	5.0	CPL, 2020.
6.	CRDC Bn-40	7 396 820	5 035 693	83.71	28.0	5.4	CPL, 2020.
7.	CRDC Bn-41	7 396 897	5 035 648	84.01	28.0	5.6	CPL, 2020.
8.	CRDC Cpt-25	7 396 602	5 035 700	79.81	34.0	-	CPL, 2020.
9.	CRDC Cpt-26	7 396 646	5 035 693	81.93	34.0	-	CPL, 2020.
10.	CRDC SCpt-27	7 396 688	5 035 690	82.48	30.7	-	CPL, 2020.
11.	CRDC Cpt-28	7 396 735	5 035 693	82.89	34.0	-	CPL, 2020.
12.	CRDC Cpt-29	7 396 793	5 035 683	83.65	31.2	-	CPL, 2020.
13.	CRDC SCpt-30	7 396 840	5 035 680	83.81	33.6	-	CPL, 2020.

2.1.1 STANDARD PENETRATION TEST – SPT

The standard penetration tests were performed according to the " EN ISO 22476-3" standard, so that the penetration of the standard spoon (N) was performed with small blows of a mallet weighing 63.5 kg that fell freely from a height of 0.76 m, where the number of blows with a mallet, required for three successive 15 cm penetrations is recorded, so that the first measurement is not taken into account, and the final result N is the sum of the second and third counts with a total penetration of 30 cm.

The obtained N impact data were corrected using the models given in EN ISO 22476-3: 2005, while the relative compactions and internal friction angles were determined based on the recommendations given in SRPS EN 1997-2. **Tables 3, 4, 5, 6, 7, 8** and **9** show the results of SPT N correction in trial pits and the derived correlations with the relative compaction and internal friction angle of the isolated lithological environments.

Table 3*. Results of SPT tests processing performed in CRDC Bn-35*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
siSa	11.0	10.5	25	81	34	0.878	1.0	30	71	37
SaP	25.0	14.5	25		34	0.766	1.0	26	66	36
		21.0	32		43	0.641	1.0	28	69	37
		23.5	36		49	0.610	1.0	30	71	37

Table 4*. Results of SPT tests processing performed in CRDC Bn-36*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
CIL-CII	15.4	8.0	183	81	18	-	-	-	-	-
		14.5	45		61	-	-	-	-	-
SaP	26.0	21.0	33		45	0.630	1.0	28	69	37
		24.0	34		46	0.595	1.0	27	67	36

Table 5. *Results of SPT tests processing performed in CRDC Bn-37*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
ClL-ClI	14.1	11.0	23	81	31	-	-	-	-	-
siSa	18.5	16.5	37		50	0.682	1.0	34	76	38
SaP	27.0	23.0	39		53	0.596	1.0	31	72	37
		26.0	48		65	0.566	1.0	37	79	39

Table 6*. Results of SPT tests processing performed in CRDC Bn-38*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
ClL-ClI	12.1	11.0	4	81	5	-	-	-	-	-
siSa	21.1	17.0	38		51	0.632	1.0	32	73	37
SaP	27.0	23.0	37		50	0.567	1.0	28	69	37
		26.0	36		49	0.541	1.0	26	66	36

Table 7*. Results of SPT tests processing performed in CRDC Bn-39*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
siSa	21.0	10.5	22	81	30	0.795	1.0	24	63	35
		16.5	24		32	0.691	1.0	22	60	35
SaP	27.0	22.5	46		62	0.608	1.0	38	80	39
		25.5	38		51	0.576	1.0	30	71	37

Table 8*. Results of SPT tests processing performed in CRDC Bn-40*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
siSa	13.1	7.0	8	81	11	0.883	0.95	9	37	34
saSi	22.0	18.0	39		53	-	-	-	-	-
SaP	28.45	24.0	37		50	0.560	1.0	28	69	37
		28.0	40		54	0.527	1.0	28	69	37

Table 9*. Results of SPT tests processing performed in CRDC Bn-41*

Layer designation	Lower limit of the layer (m)	Depth of test performance (m)	N	E_r (%)	N_{60}	C_N	Cr	$(N_1)_{60}$	Dr (%)	φ [°]
ClL-ClI	6.9	6.5	9	81	12	-	-	-	-	-
saSi	24.0	12.0	35		47	0.731	1.0	35	77	38
		18.0	35		47	0.634	1.0	30	71	37
SaP	28.45	24.0	38		51	0.562	1.0	29	70	37
		28.0	43		58	0.526	1.0	31	72	37

2.1.2 CONE PENETRATION TEST - CPT

Processing of the obtained results as well as correction of the value of soil resistance to penetration of the cone qc in order to obtain the parameters of deformability and strength was performed in accordance with SRPS EN 1997-2. Coefficient α values (SRPS EN 1997-2), determined based on soil type and cone resistance qc are shown in **Table 10.**

Table 10. *Coefficient α values – Sanglerat, 1972.*

Type of soil	Cone resistance q_c (MPa)	Coefficient α
CL - clay of low plasticity	$q_c \leq 0.7$ $0.7 < q_c < 2$ $q_c \geq 2$	$3 < \alpha < 8$ $2 < \alpha < 5$ $1 < \alpha < 2.5$
ML - silt of low plasticity	$q_c < 2$ $q_c \geq 2$	$3 < \alpha < 6$ $1 < \alpha < 2$
CH - highly plastic clay	$q_c < 2$	$2 < \alpha < 6$
MH - highly plastic silt	$q_c \geq 2$	$1 < \alpha < 2$
OL - highly plastic organic silt	$q_c < 1.2$	$2 < \alpha < 8$
Pt-OH - peat and highly organic clay	$q_c < 0.7$ $50 < \omega \leq 100\%$ $100 < \omega \leq 200\%$ $\omega > 200\%$	 $1.5 < \alpha < 4$ $1 < \alpha < 1.5$ $0.4 < \alpha < 1.0$
Chalk – soft carbonate chalk	$2 < q_c \leq 3$ $q_c > 3$	$2 < \alpha < 4$ $1.5 < \alpha < 3$
Sand	$q_c < 5$ $q_c > 10$	$\alpha = 2$ $\alpha = 1.5$

Tables 11, 12, 13, 14, 15 and **16** show the interpretation of the CPT test results.

Table 11. *CPT test Cpt-25 results*

Layer designation	Lower limit of the layer (m)	qc (kPa)	fs (kPa)	Rf (%)	α	Mv (kPa)	φ (°)
							EC7
nt	1.5	4000	-	-	-	-	-
ClL-Cll	10.1	2000	60	3.0	1.5	3000	-
siSa	14.5	5000	40	0.8	2.0	10000	32
SaP	34.0	17000	120	0.7	1.5	25500	40

Table 12. *CPT test Cpt-26 results*

Layer designation	Lower limit of the layer (m)	qc (kPa)	fs (kPa)	Rf (%)	α	Mv (kPa)	φ (°)
							EC7
nt	2.0	2000	-	-	-	-	-
ClL-Cll	15.5	2500	60	2.4	1.5	3750	-
siSa	18.4	15000	120	0.8	1.5	22500	39
saSi	23.0	11000	60	0.6	1.5	16500	37
SaP	34.0	17000	100	0.6	1.5	25500	40

Table 13. *CPT test SCpt-27 results*

Layer designation	Lower limit of the layer (m)	qc (kPa)	fs (kPa)	Rf (%)	α	Mv (kPa)	φ (°)
							EC7
nt	2.5	5000	-	-	-	-	-
ClL-Cll	13.7	2000	35	1.8	1.5	3000	-
siSa	18.0	6000	50	0.8	1.9	11400	33
saSi	21.9	14000	60	0.4	1.0	14000	-
SaP	30.7	15000	70	0.5	1.5	22500	39

Table 14. *CPT test Cpt-28 results*

Layer designation	Lower limit of the layer (m)	qc (kPa)	fs (kPa)	Rf (%)	α	Mv (kPa)	φ (°) EC7
nt	2.9	5000	-	-	-	-	-
ClL-Cll	9.1	2000	70	3.5	1.5	3000	-
siSa	17.7	8000	50	0.6	1.7	13600	35
SaP	34.0	16000	120	0.8	1.5	24000	39

Table 15. *CPT test Cpt-29 results*

Layer designation	Lower limit of the layer (m)	qc (kPa)	fs (kPa)	Rf (%)	α	Mv (kPa)	φ (°) EC7
ClL-Cll	6.7	3000	90	3.0	1.5	4500	-
siSa	10.8	11000	90	0.8	1.5	16500	-
	15.0	14000	100	0.7	1.5	21000	38
	19.5	11000	90	0.8	1.5	16500	37
SaP	31.6	15000	100	0.7	1.5	22500	39

Table 16. *CPT test SCpt-30 results*

Layer designation	Lower limit of the layer (m)	qc (kPa)	fs (kPa)	Rf (%)	α	Mv (kPa)	φ (°) EC7
ClL-Cll	5.9	3000	60	2.0	1.5	4500	-
siSa	13.9	12000	50	0.4	1.5	18000	37
saSi	23.0	11000	75	0.7	1.0	11000	-
SaP	25.1	20000	100	0.5	1.5	30000	40
	30.6	8000	90	1.1	1.2	9600	-
	33.7	15000	120	0.8	1.5	22500	39

2.1.3 CHARACTERISTICS OF GEOTECHNICAL ENVIRONMENTS

Based and processing of the results of field research and testing, the engineering-geological characteristics of the selected lithological environments with the values of physical-mechanical parameters were defined in the area of the planned facility. The terrain, starting from its surface, is built by the following sediments:

Humus (h) 0.00 m - ≤0.30 m - dark brown in color, silty, with the participation of organic matter. Since the surface layer will be removed during construction, no laboratory soil tests have been performed within this layer.

Embankment (nt) 0.00 m - ≤3.00 m - dark brown in color. Since the surface layer will be removed during construction, no laboratory soil tests have been performed within this layer.

Silty clay (CIL-Cll) ≥0.20 m - ≤15.40 m - to clayey silt, yellow to brown in color. Low plastic to intermediate plastic soil, firm to very stiff consistent condition. Laboratory geomechanical testing of samples from exploration wells yielded the following values of physical and mechanical parameters of the soil (**Table 17**).

Table 17*. Review of laboratory test results*

Investigation work:	CPL CRDC Bn-35 to CRDC Bn-41
Layer:	ClL-Cll
Clay (%)	19 - 59
Silt (%)	40 - 80
Sand (%)	0 - 30
γ (kN/m^3)	19.2 - 21.4
γ_d (kN/m^3)	14.4 - 17.6
W (%)	18.1 - 32.8
W_L (%)	30.0 - 51.5
W_P (%)	18.8 - 25.4
I_P	9.2 - 29.4
I_C	0.4 - 1.4
c (kN/m^2)	4 - 35
φ (°)	16 - 25
$Mv_{0\text{-}50}$ (kN/m^2)	1126 - 2007
$Mv_{50\text{-}100}$ (kN/m^2)	2041 - 4187
$Mv_{100\text{-}200}$ (kN/m^2)	3546 - 5876
$Mv_{200\text{-}400}$ (kN/m^2)	5735 - 10206

Silty sand (siSa) ≥6.90 m - ≤21.10 m - yellow to grey, with a low content of clay, fine-grained, medium dense to dense. It is characterized with an interlayers of sand and sandy silt. Laboratory geomechanical testing of samples from exploration wells yielded the following values of physical and mechanical parameters of the soil (**Table 18**).

***Table 18**. Review of laboratory test results*

Investigation work:	CPL CRDC Bn-35 to CRDC Bn-41
Layer:	siSa
Clay (%)	0 - 14
Silt (%)	4 - 41
Sand (%)	54 - 96
γ (kN/m^3)	20.1 - 21.8
γ_d (kN/m^3)	15.7 - 18.9
W (%)	12.8 - 35.8
c (kN/m^2)	6 - 13
φ (°)	24 - 33
Mv_{0-50} (kN/m^2)	1675 - 3105
Mv_{50-100} (kN/m^2)	3951 - 5086
$Mv_{100-200}$ (kN/m^2)	7108 - 9965
$Mv_{200-400}$ (kN/m^2)	12503 - 17444

Sandy silt (saSi) ≥11.30 m - ≤24.00 m - yellow to grey, characterized by a higher contents of silt and clay, dense. It is characterized with an interlayers of sand. Laboratory geomechanical testing of samples from exploration wells yielded the following values of physical and mechanical parameters of the soil (**Table 19**).

***Table 19**. Review of laboratory test results*

Investigation work:	CPL CRDC Bn-37, CRDC Bn-39 to CRDC Bn-41
Layer:	saSi
Clay (%)	0 - 22
Silt (%)	29 - 80
Sand (%)	20 - 50
γ (kN/m^3)	19.4 - 21.9
γ_d (kN/m^3)	15.8 - 19.3
W (%)	13.5 - 23.5
c (kN/m^2)	4 - 17
φ (°)	19 - 29
Mv_{0-50} (kN/m^2)	872 - 3018
Mv_{50-100} (kN/m^2)	2676 - 7243
$Mv_{100-200}$ (kN/m^2)	4872 - 10000
$Mv_{200-400}$ (kN/m^2)	8741 - 17300

Sand (SaP) ≥11.00 m - 28.45 m - grey in color, fine-grained, poorly graded, dense. It is characterized with an interlayers of sandy silt. Laboratory geomechanical testing of samples from exploration wells yielded the following values of physical and mechanical parameters of the soil (**Table 20**).

***Table 20**. Review of laboratory test results*

Investigation work:	CPL CRDC Bn-35 to CRDC Bn-41
Layer:	SaP
Clay (%)	0
Silt (%)	1 - 10
Sand (%)	90 - 99
γ (kN/m^3)	20.7 - 21.5
γ_d (kN/m^3)	17.7 - 18.2
W (%)	8.6 - 23.5
c (kN/m^2)	4
φ (°)	31 - 36
Mv_{0-50} (kN/m^2)	1746 - 3558
Mv_{50-100} (kN/m^2)	4760 - 7143
$Mv_{100-200}$ (kN/m^2)	8751 - 15385
$Mv_{200-400}$ (kN/m^2)	17163 - 23529

2.1.4 RELEVANT PARAMETERS OF GEOTECHNICAL ENVIRONMENTS

Descriptions of the properties of layers, their characteristics of importance for the assessment of geotechnical conditions of construction and foundation of the structure are given in the previous chapters.

It is important to notify that φ, c and M_v are adopted values, while the values of E_s and k_h are calculated on the basis of the static penetration test, more precisely on the basis of the values of the resistance of the cone q_c (values of q_c are shown in Chapter 2.1.2). On this way, the increase in the value of the coefficient of subsoil reaction per depth is shown, which is a logical process considering that the value of the cone resistance increases with increasing depth. The designer of the structure is enabled to select the value of the subsoil reaction coefficient by himself.

According to Vesić's theory from 1961., the values of the soil reaction coefficient (k_h) were determined by the soil elasticity modulus (E_s), pile diametar (d), Poisson's ratio (ν), moment of inertia (I_p) and modulus of elasticity of the pile (E_p), using folowing formulas:

$$k_h = \frac{0.65}{d} \cdot \sqrt[12]{\frac{E_s \cdot d^4}{E_p \cdot I_p}} \cdot \frac{E_s}{1 - \nu^2} \qquad \text{(Vesić, 1961.)}$$

$$M_v = E_s \cdot \frac{1 - \nu}{(1 - 2\nu) \cdot (1 + \nu)} \qquad \text{(Elasticity theory)}$$

$$I_p = \frac{r^4 \pi}{4} \qquad \text{moment of inertia of a circular pile}$$

While according to Mayerhof and Baike theory from 1963., the values of the soil reaction coefficient (k_h) were determined by the soil elasticity modulus (E_s), pile diametar (d) and Poisson's ratio (ν), using folowing formula:

$$k_h = \frac{E_s}{d \cdot (1 - \nu^2)} \qquad \text{(Mayerhof \& Baike, 1963.)}$$

The relevant soil parameters for geostatic calculations in the zones in which the pile foundation will be performed were adopted on the basis of laboratory and terrain tests and are shown in **Tables 21-32**.

Thirteen terrain models have been defined, for an individual pillar site.

Table 21. *Overview of adopted soil parameters for pillar site 1 (S1)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	2.4	2.4	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	2.7	0.3	10								
siSa	8.6	5.9	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	10.2	1.6	10	31	4	22500	0.2	20.25		17.58	7.99
saSi	14.6	4.4	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	18.0	3.4	10	31	4	22500	0.2	20.25		17.58	7.99
saSi	22.2	4.2	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	11.8*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 22. *Overview of adopted soil parameters for pillar site 2 (S2)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	1.8	1.8	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	2.1	0.3	10								
siSa	9.5	7.4	10	28	6	18000	0.3	13.37		12.24	5.38
saSi	16.7	7.2	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	19.7	3.0	10	31	4	22500	0.2	20.25		17.58	7.99
saSi	24.1	4.4	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	9.9*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 23. *Overview of adopted soil parameters for pillar site 3 (S3)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	2.2	2.2	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	2.8	0.6	10								
siSa	10.3	7.5	10	28	6	18000	0.3	13.37		12.24	5.38
saSi	19.6	9.3	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	23.0	3.4	10	31	4	22500	0.2	20.25		17.58	7.99
saSi	26.8	3.8	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	7.2*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 24. *Overview of adopted soil parameters for pillar site 4 (S4)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	3.4	3.4	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	4.3	0.9	10								
saSi	5.6	1.3	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	7.9	2.3	10	31	4	22500	0.2	20.25		17.58	7.99
siSa	15.6	7.7	10	28	6	18000	0.3	13.37		12.24	5.38
saSi	19.4	3.8	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	14.6*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 25. *Overview of adopted soil parameters for pillar site 5 (S5)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	4.0	2.1	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	6.7	2.7	10								
saSi	7.9	1.2	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	9.8	1.9	10	31	4	22500	0.2	20.25		17.58	7.99
siSa	14.8	5.0	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	16.4	1.6	10	31	4	22500	0.2	20.25		17.58	7.99
siSa	19.1	2.7	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	34.0*	14.9*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 26. *Overview of adopted soil parameters for pillar site 6 (S6)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	5.6	3.3	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	8.2	2.6	10								
siSa	16.8	8.6	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	34.0*	17.2*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 27. *Overview of adopted soil parameters for pillar site 7 (S7)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	6.9	6.9	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	12.0	5.1	10								
siSa	21.1	9.1	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	34.0*	12.9*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 28. *Overview of adopted soil parameters for pillar site 8 (S8)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	6.3	3.6	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	14.0	7.7	10								
siSa	19.0	5.0	10	28	6	18000	0.3	13.37		12.24	5.38
saSi	22.2	3.2	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	11.8*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 29. *Overview of adopted soil parameters for pillar site 9 (S9)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	4.5	4.5	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	13.9	9.4	10								
siSa	18.3	4.4	10	28	6	18000	0.3	13.37		12.24	5.38
saSi	22.8	4.5	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	11.2*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 30. *Overview of adopted soil parameters for pillar site 10 (S10)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	5.0	2.7	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	15.2	10.2	10								
siSa	18.2	3.0	10	28	6	18000	0.3	13.37		12.24	5.38
saSi	22.8	4.6	10	24	11	11000	0.3	8.17		7.48	3.15
SaP	34.0*	11.2*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 31. *Overview of adopted soil parameters for pillar site 11 (S11)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	6.7	3.7	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	18.4	11.7	10								
siSa	21.4	3.0	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	34.0*	12.6*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 32. *Overview of adopted soil parameters for pillar site 12 (S12)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	6.2	1.4	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	14.2	8.0	10								
siSa	18.7	4.5	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	34.0*	15.3*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

Table 32. *Overview of adopted soil parameters for pillar site 13 (S13)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m³)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
CIL-CII	5.9	1.0	19.2	18	20	4500	0.4	2.10	30000	2.08	0.78
	12.3	6.4	10								
siSa	15.9	3.6	10	28	6	18000	0.3	13.37		12.24	5.38
SaP	34.0*	18.1*	10	31	4	22500	0.2	20.25		17.58	7.99

*depth determined from CPT test

3 GEOTECHNICAL CONDITIONS OF FOUNDATION OF FACILITIES

Geotechnical conditions of construction of the facility, as well as its general stability are defined on the basis of :

- geotechnical characteristics of the specified layers engaged in the foundation of the facility,
- analysis of allowable bearing capacity of soil,
- analysis of prognostic soil settlement.

In this chapter, geostatic calculations were made for thirteen terrain models for individual pillar sites 1-13, based on the results of which the impacts of objects on the ground will be considered. Input data for the calculation of bearing capacity and settlement of an individual pile as well as a group of piles were adopted on the basis of data obtained by the Investor, showed in **Table 33**.

Table 33. *Review of expected loads*

Pillar site	Single pile		Group of piles	
	ULS	SLS	ULS	SLS
	Nmax	Nmax	Nmax	Nmax
S1	4000*	-	24000*	-
S2	4078	-	12234	-
S3	4216	-	12648	-
S4	4167	-	12501	-
S5	4136	-	12408	-
S6	4475	-	13425	-
S7	4500*	-	27000*	-
S8	4607	-	13821	-
S9	4217	-	12651	-
S10	4284	-	12852	-
S11	4289	-	12867	-
S12	4024	-	12072	-
S13	4000*	-	24000*	-

*trials values of forces

All values of forces are preliminary and don't affect on result of bearing capacity, but serve only as data for comparison. After receiving the final values of forces, bearing capacity and settlement results will be updated.

The minimum groundwater level was adopted at a depth of 1.8 m, while the maximum groundwater level was adopted at a depth of 6.9 m from the ground surface.

3.1 DETERMINATION OF BEARING CAPACITY AND SETTLEMENT OF PILES

The analysis of bearing capacity and settlement of individual piles and groups of piles were performed on the basis of the adopted depths of foundation, dimensions of individual piles and arrangement of piles in the group. The analysis were performed with the design values of the parameters of the geotechnical section.

The calculations were performed in the Geo5 software, using the Pile group software package. Calculations were performed for design approach 2 (DA-2). For analytical type of analyze, the coefficient of efficiency of pile group is inputed automatically by software and considered at the review of results of bearing capacity of pile group. For spring type of analyze, the coefficient of efficiency of pile group is considered at the review of results of bearing capacity of single pile. In this case, analytical type of analyze is selected for pillar sites 1, 7 and 13, while spring type of analyze is selected for pillar sites 2 - 6 and 8 - 12.

The results of bearing capacity analysis obtained for the adopted terrain models for the case of foundation of an individual pile as well as on a group of piles are given in **Table 34**.

Calculations were made with the adoption of several different lengths of piles.

Table 34. *Review of the results of bearing capacity and settlement analysis of individual piles and groups of piles*

Pillar site	Length of pile	Diameter of pile	Analysis results, SRPS EN 1997-1, DA-2			Settlement of pile group
	L_s (m)	d (m)	R_s (kN)	R_b (kN)	R_c (kN)	s (mm)
S1	17.0	1.2	2994.87	555.21	3550.08	-
	18.0	1.2	3107.97	555.21	3663.17	-
	19.0	1.2	3221.07	555.21	3776.27	-
	20.0	1.2	3334.16	2995.27	6329.43	-
	21.0	1.2	3812.65	3127.29	6939.94	-
	26.0	1.2	6514.60	3787.36	10301.96	-
S2	17.0	1.2	2908.11	2547.65	5019.30	-
	18.0	1.2	3244.40	1027.56	3930.20	-
	19.0	1.2	3522.48	1072.16	4227.07	-
	20.0	1.2	3812.37	1116.77	4534.81	-
	21.0	1.2	4114.08	1161.38	4853.42	-
	26.0	1.2	6571.11	3665.22	9417.43	-
S3	17.0	1.2	2931.17	983.09	3601.13	-
	18.0	1.2	3284.05	2681.64	5488.44	-
	19.0	1.2	3713.52	2813.66	6005.00	-
	20.0	1.2	4163.62	2945.67	6540.55	-
	21.0	1.2	4600.96	1182.49	5320.78	-
	27.0	1.2	7172.79	3808.83	10103.09	-
S4	17.0	1.2	3515.03	1053.47	4203.02	-
	18.0	1.2	3923.07	2867.82	6247.62	-
	19.0	1.2	4381.64	2999.83	6790.96	-
	20.0	1.2	4860.84	3131.85	7353.27	-
	21.0	1.2	5360.67	3263.87	7934.58	-
	28.0	1.2	9417.06	4187.97	12516.63	-
S5	17.0	1.2	3830.48	2827.97	6125.77	-
	18.0	1.2	4282.82	2959.98	6663.38	-
	19.0	1.2	4755.79	3092.00	7219.97	-
	20.0	1.2	5249.40	3224.01	7795.54	-
	21.0	1.2	5763.64	3356.03	8390.09	-
	29.0	1.2	10560.97	4412.15	13775.27	-
S6	17.0	1.2	3988.23	3010.20	6438.55	-
	18.0	1.2	4469.05	3142.21	7002.36	-
	19.0	1.2	4970.50	3274.23	7585.15	-
	20.0	1.2	5492.59	3406.24	8186.93	-
	21.0	1.2	6035.32	3538.26	8807.69	-
	29.0	1.2	11060.52	4594.38	14402.51	-

Pillar site	Length of pile	Diameter of pile	Analysis results, SRPS EN 1997-1, DA-2			Settlement of pile group
	L_s (m)	d (m)	R_s (kN)	R_b (kN)	R_c (kN)	s (mm)
S7	17.0	1.2	3317.14	2073.75	5390.89	-
	18.0	1.2	3730.06	2156.83	5886.88	-
	19.0	1.2	4167.97	3360.59	7528.56	-
	20.0	1.2	4703.56	3492.61	8196.17	-
	21.0	1.2	5259.78	3624.63	8884.41	-
	31.0	1.2	11757.16	4944.78	16701.94	-
S8	17.0	1.2	2794.44	1158.72	3636.90	-
	18.0	1.2	3107.26	1203.32	3965.73	-
	19.0	1.2	3431.89	1247.93	4305.43	-
	20.0	1.2	3768.34	3360.59	6558.62	-
	21.0	1.2	4303.93	3492.61	7172.81	-
	29.0	1.2	9272.05	4548.73	12715.12	-
S9	17.0	1.2	2611.35	1071.40	3388.13	-
	18.0	1.2	2901.04	1116.01	3695.68	-
	19.0	1.2	3202.54	1160.62	4014.11	-
	20.0	1.2	3515.87	1205.22	4343.40	-
	21.0	1.2	3911.45	3255.97	6594.02	-
	29.0	1.2	8583.66	4312.09	11864.10	-
S10	17.0	1.2	2361.57	1089.25	3174.75	-
	18.0	1.2	2655.98	1133.85	3486.65	-
	19.0	1.2	2962.22	1178.46	3809.42	-
	20.0	1.2	3280.26	1223.06	4143.06	-
	21.0	1.2	3681.58	3302.36	6425.23	-
	29.0	1.2	8411.81	4358.48	11748.67	-
S11	17.0	1.2	1668.94	2009.92	3384.56	-
	18.0	1.2	2069.40	2093.00	3829.40	-
	19.0	1.2	2486.07	2176.07	4289.17	-
	20.0	1.2	2989.22	3394.65	5873.16	-
	21.0	1.2	3530.13	3526.66	6492.25	-
	30.0	1.2	9207.61	4714.80	12808.62	-
S12	17.0	1.2	2795.81	3003.54	5335.40	-
	18.0	1.2	3275.59	3135.55	5898.25	-
	19.0	1.2	3776.00	3267.57	6480.09	-
	20.0	1.2	4297.05	3399.58	7080.90	-
	21.0	1.2	4838.73	3531.60	7700.71	-
	30.0	1.2	10523.16	4719.74	14023.46	-
S13	17.0	1.2	3387.61	3008.35	6395.96	-
	18.0	1.2	3868.14	3140.36	7008.51	-
	19.0	1.2	4369.31	3272.38	7641.69	-
	20.0	1.2	4891.11	3404.39	8295.50	-
	21.0	1.2	5433.54	3536.41	8969.95	-
	30.0	1.2	11124.74	4724.55	15849.28	-

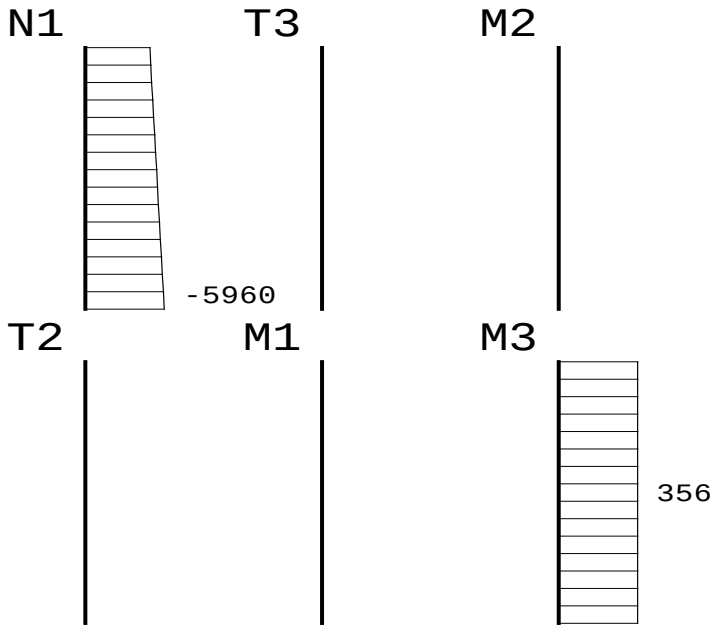
*red colored numbers with unsatisfactory bearing capacity for an individual pile and/or pile group

The results of the verification of the bearing capacity of the pile batteries are given in **Attachments 1.8.1-78**.

4.6.9 **Стуб С7 /** Piers S7

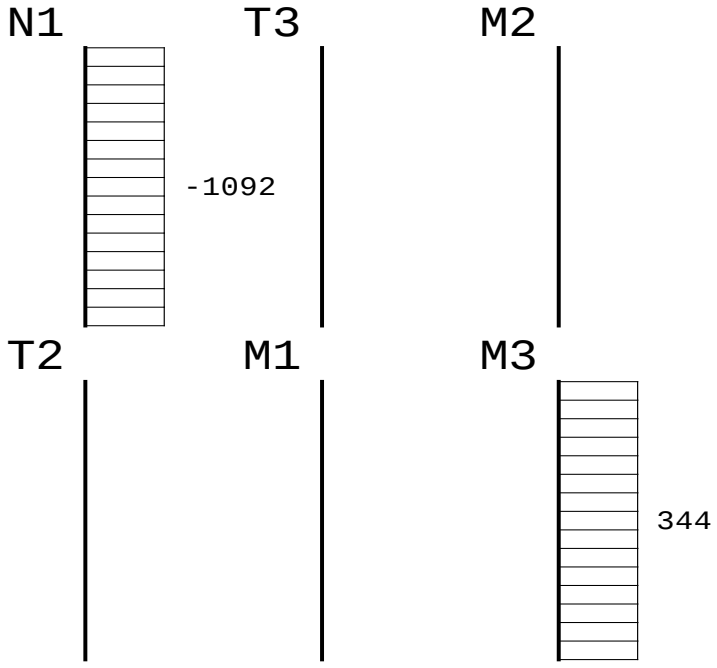
Structural analysis – S7

Opt. 1: Sopstvena tezina (g)



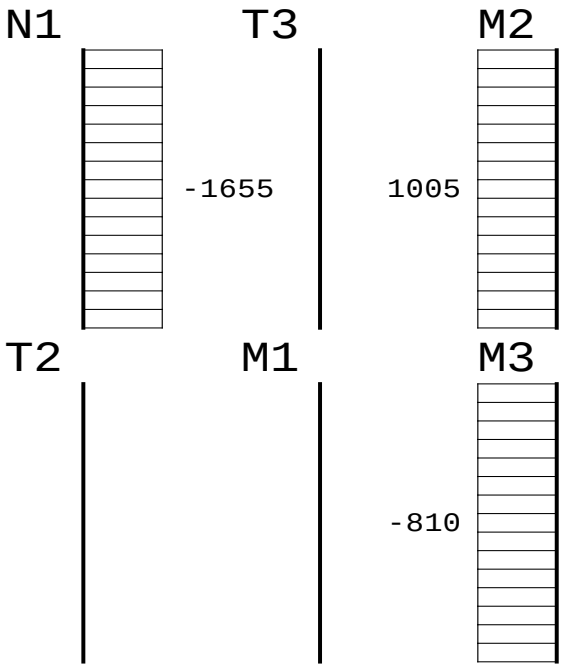
Uticaji u gredi: (161-219)
N1 [kN], T2 [kN], T3 [kN], M1 [kNm], M2 [kNm], M3 [kNm]

Opt. 2: Dodato stalno



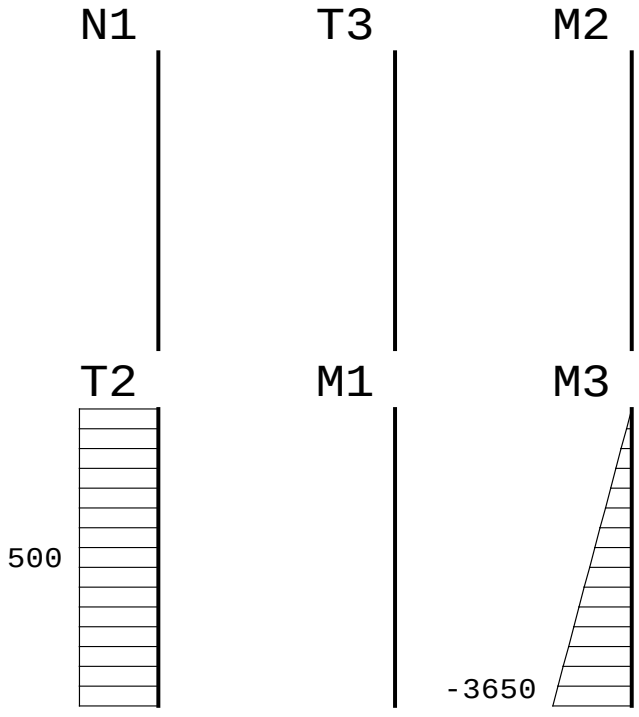
Uticaji u gredi: (161-219)
N1 [kN], T2 [kN], T3 [kN], M1 [kNm], M2 [kNm], M3 [kNm]

Opt. 3: Pokretno



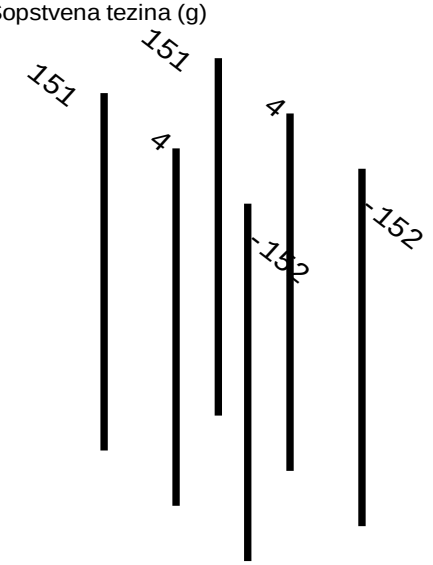
Uticaji u gredi: (161-219)
N1 [kN], T2 [kN], T3 [kN], M1 [kNm], M2 [kNm], M3 [kNm]

Opt. 4: Sy



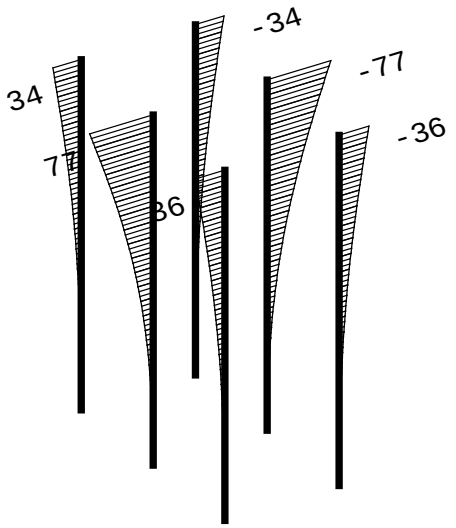
Uticaji u gredi: (161-219)
N1 [kN], T2 [kN], T3 [kN], M1 [kNm], M2 [kNm], M3 [kNm]

Opt. 1: Sopstvena tezina (g)



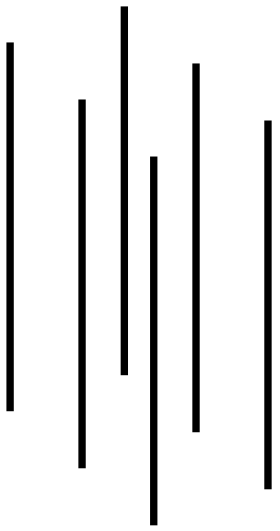
Grupa: Sipovi
Uticaji u gredi: max M3= 356 / min M3= -4874 kNm

Opt. 1: Sopstvena tezina (g)



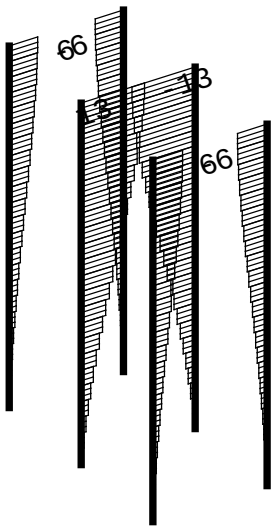
Grupa: Sipovi
Uticaji u gredi: max M2= 77 / min M2= -77 kNm

Opt. 1: Sopstvena tezina (g)



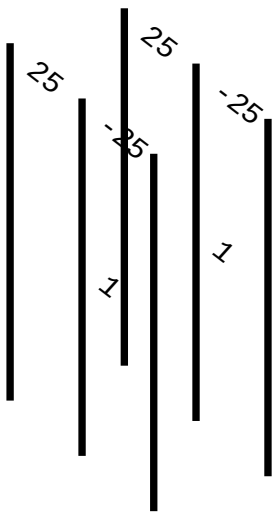
Grupa: Sipovi
Uticaji u gredi: max M1= 0 / min M1= -0 kNm

Opt. 1: Sopstvena tezina (g)



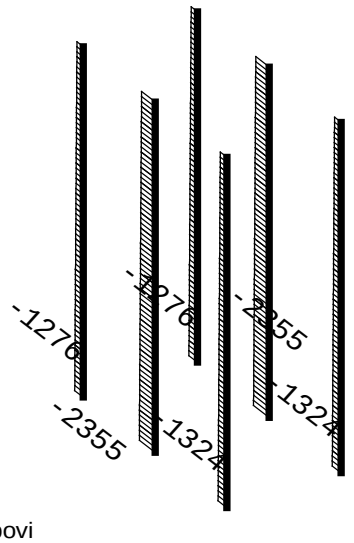
Grupa: Sipovi
Uticaji u gredi: max T3= 13 / min T3= -13 kN

Opt. 1: Sopstvena tezina (g)



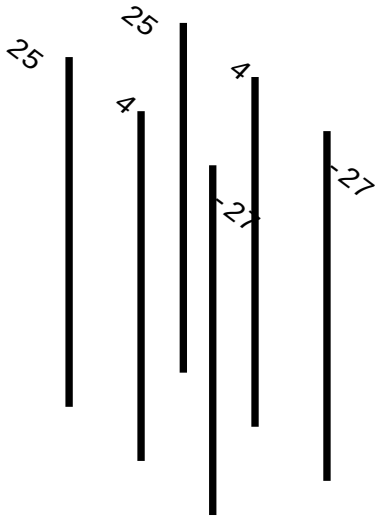
Grupa: Sipovi
Uticaji u gredi: max T2= 2344 / min T2= -2522 kN

Opt. 1: Sopstvena tezina (g)



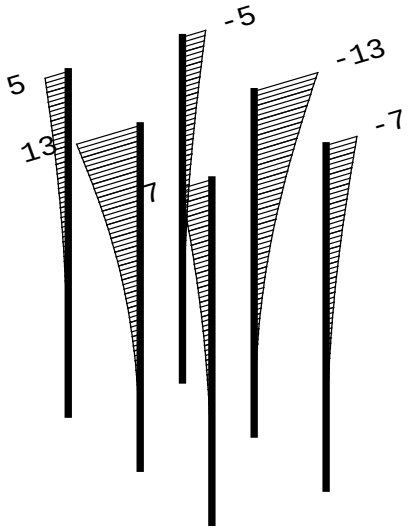
Grupa: Sipovi
Uticaji u gredi: max N1= 0 / min N1= -5960 kN

Opt. 2: Dodato stalno



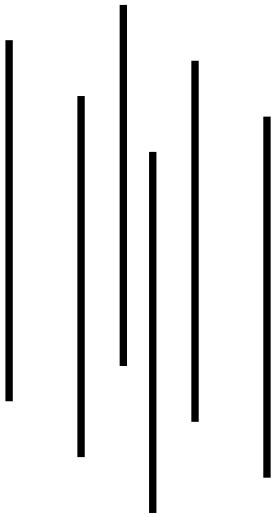
Grupa: Sipovi
Uticaji u gredi: max M3= 344 / min M3= -1264 kNm

Opt. 2: Dodato stalno



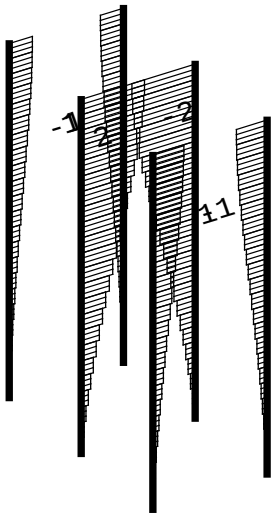
Grupa: Sipovi
Uticaji u gredi: max M2= 13 / min M2= -13 kNm

Opt. 2: Dodato stalno



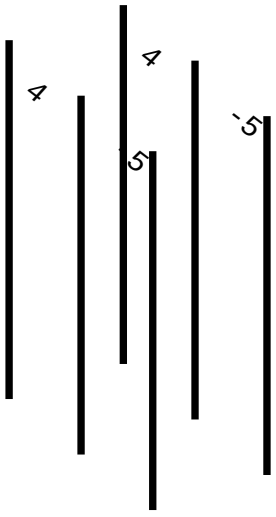
Grupa: Sipovi
Uticaji u gredi: max M1= 0 / min M1= -0 kNm

Opt. 2: Dodato stalno



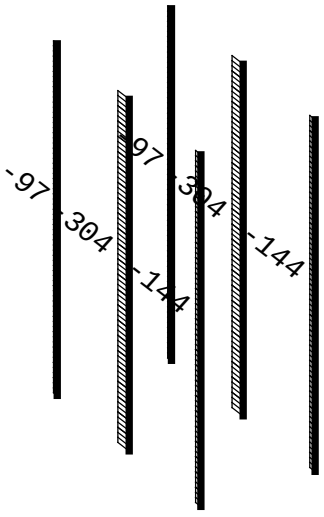
Grupa: Sipovi
Uticaji u gredi: max T3= 2 / min T3= -2 kN

Opt. 2: Dodato stalno



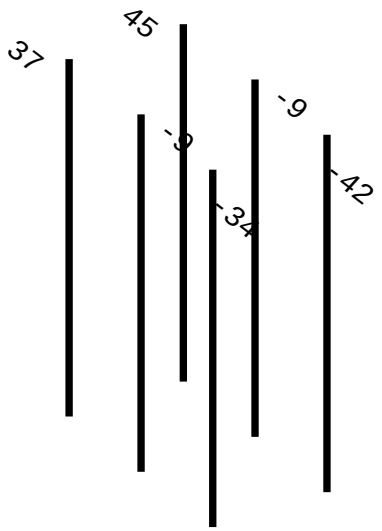
Grupa: Sipovi
Uticaji u gredi: max T2= 460 / min T2= -632 kN

Opt. 2: Dodato stalno



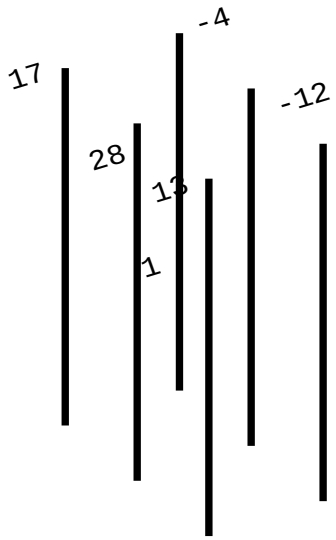
Grupa: Sipovi
Uticaji u gredi: max N1= 0 / min N1= -1092 kN

Opt. 3: Pokretno



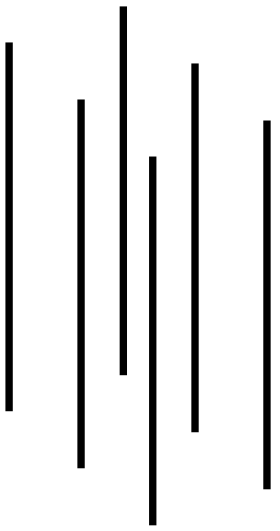
Grupa: Sipovi
Uticaji u gredi: max M3= 45 / min M3= -2060 kNm

Opt. 3: Pokretno



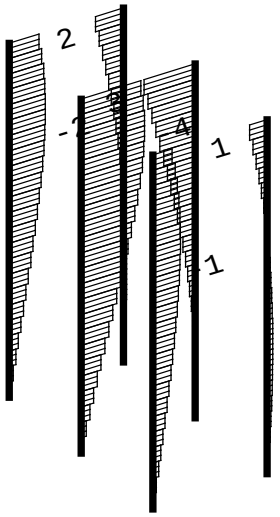
Grupa: Sipovi
Uticaji u gredi: max M2= 1005 / min M2= -12 kNm

Opt. 3: Pokretno



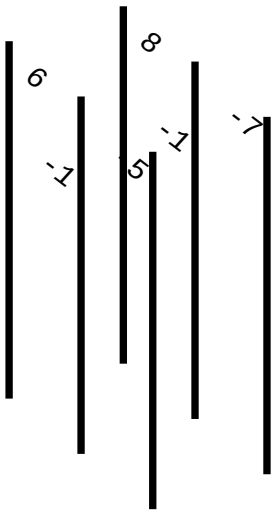
Grupa: Sipovi
Uticaji u gredi: max M1= 600 / min M1= -405 kNm

Opt. 3: Pokretno



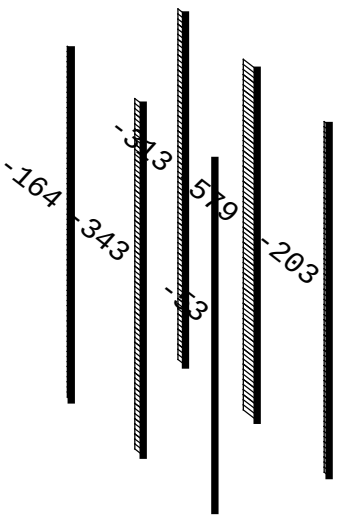
Grupa: Sipovi
Uticaji u gredi: max T3= 3 / min T3= -4 kN

Opt. 3: Pokretno



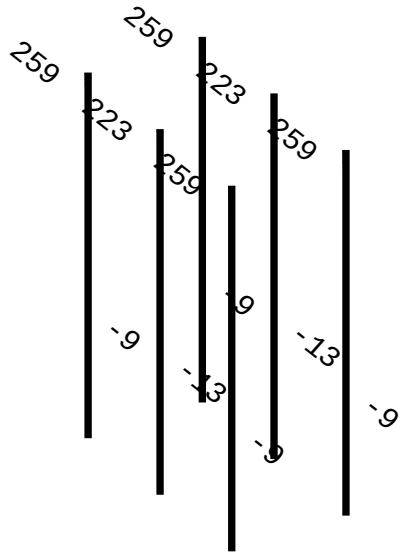
Grupa: Sipovi
Uticaji u gredi: max T2= 1030 / min T2= -815 kN

Opt. 3: Pokretno



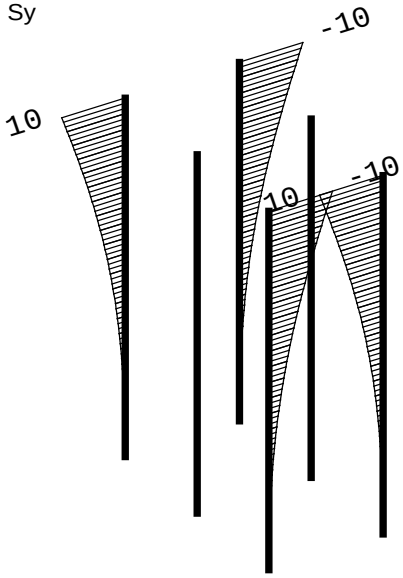
Grupa: Sipovi
Uticaji u gredi: max N1= 0 / min N1= -1655 kN

Opt. 4: Sy



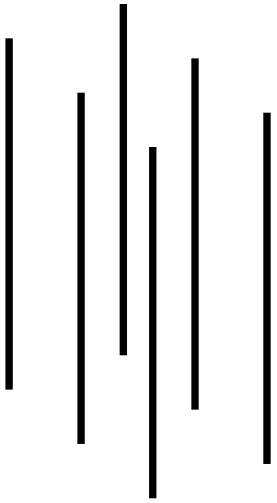
Grupa: Sipovi
Uticaji u gredi: max M3= 259 / min M3= -3650 kNm

Opt. 4: Sy



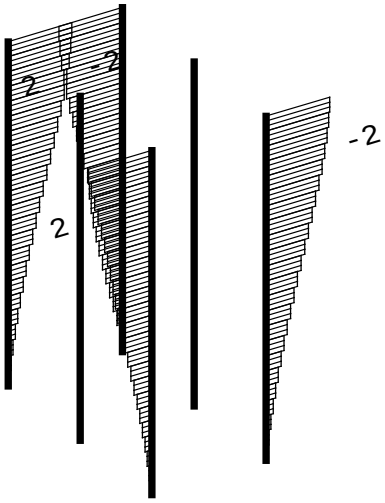
Grupa: Sipovi
Uticaji u gredi: max M2= 10 / min M2= -10 kNm

Opt. 4: Sy



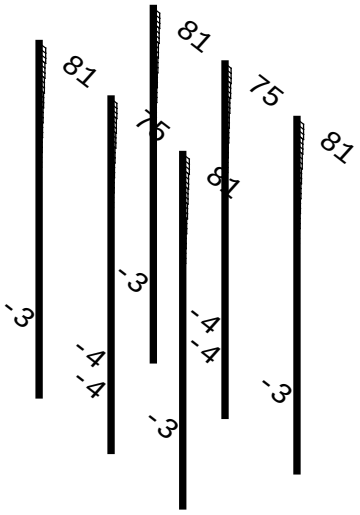
Grupa: Sipovi
Uticaji u gredi: max M1= 0 / min M1= -0 kNm

Opt. 4: Sy



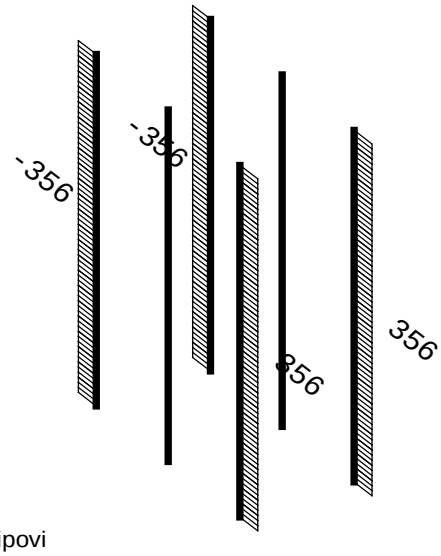
Grupa: Sipovi
Uticaji u gredi: max T3= 2 / min T3= -2 kN

Opt. 4: Sy



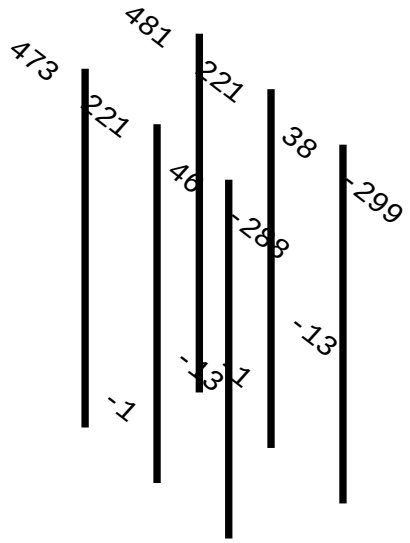
Grupa: Sipovi
Uticaji u gredi: max T2= 500 / min T2= -4 kN

Opt. 4: Sy



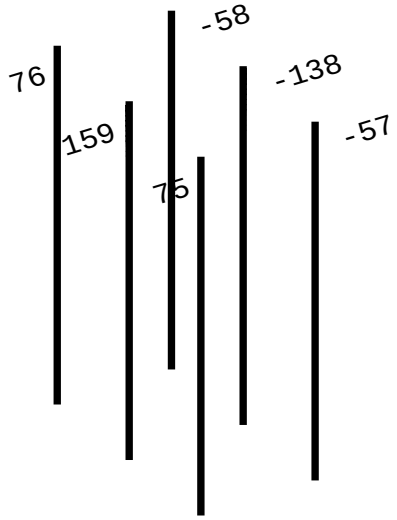
Grupa: Sipovi
Uticaji u gredi: max N1= 356 / min N1= -356 kN

Opt. 9: [Anv] 5-8



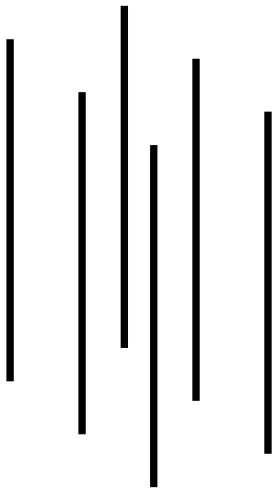
Grupa: Sipovi
Uticaji u gredi: max M3= 481 / min M3= -10123 kNm

Opt. 9: [Anv] 5-8



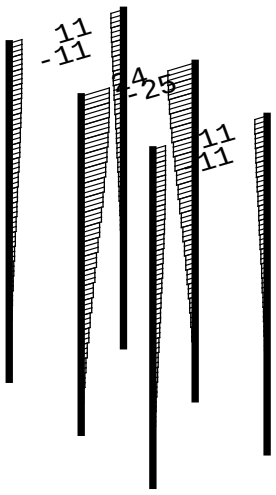
Grupa: Sipovi
Uticaji u gredi: max M2= 1357 / min M2= -138 kNm

Opt. 9: [Anv] 5-8



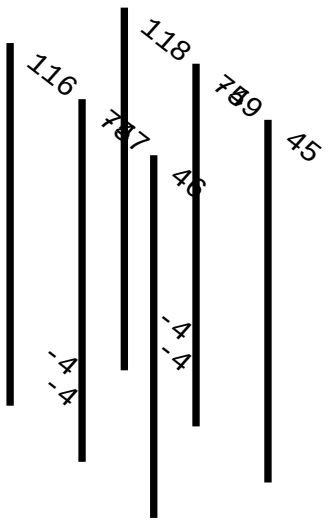
Grupa: Sipovi
Uticaji u gredi: max M1= 810 / min M1= -547 kNm

Opt. 9: [Anv] 5-8



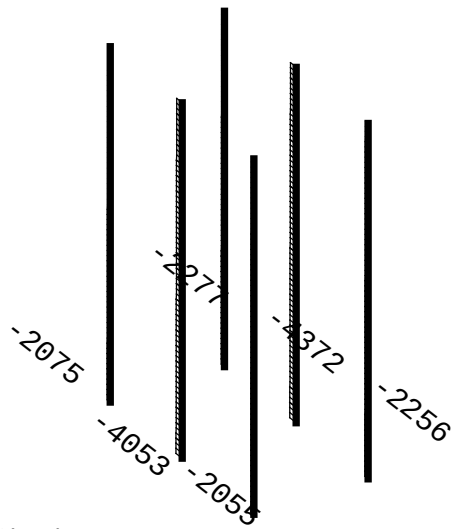
Grupa: Sipovi
Uticaji u gredi: max T3= 24 / min T3= -25 kN

Opt. 9: [Anv] 5-8



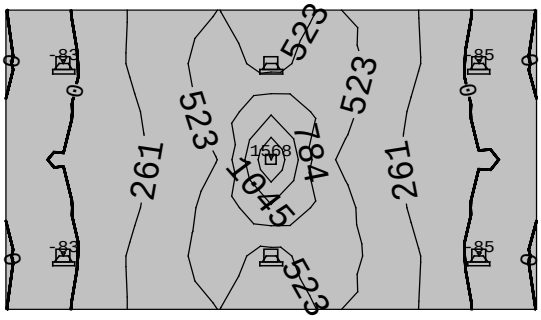
Grupa: Sipovi
Uticaji u gredi: max T2= 5175 / min T2= -5101 kN

Opt. 9: [Anv] 5-8



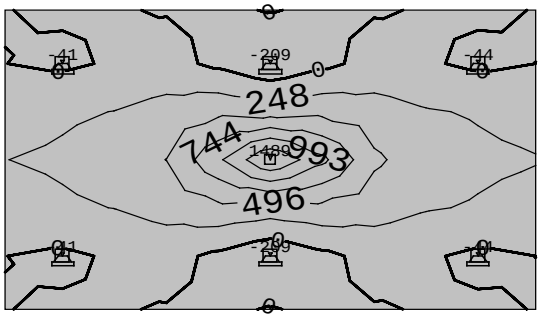
Grupa: Sipovi
Uticaji u gredi: max N1= 0 / min N1= -11754 kN

Opt. 1: Sopstvena tezina (g)



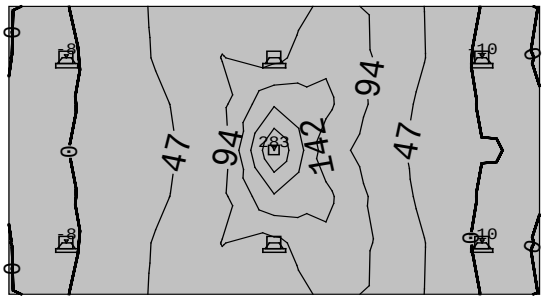
Nivo: [0.00 m]
Uticaji u ploči: max Mx= 1568 / min Mx= -85 kNm/m

Opt. 1: Sopstvena tezina (g)



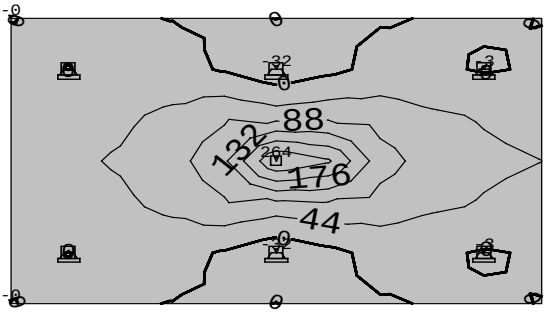
Nivo: [0.00 m]
Uticaji u ploči: max My= 1489 / min My= -209 kNm/m

Opt. 2: Dodato stalno



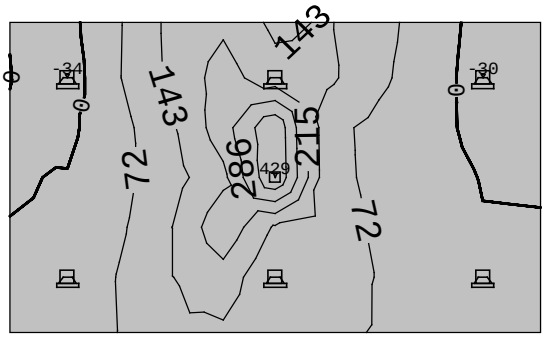
Nivo: [0.00 m]
Uticaji u ploči: max Mx= 283 / min Mx= -10 kNm/m

Opt. 2: Dodato stalno



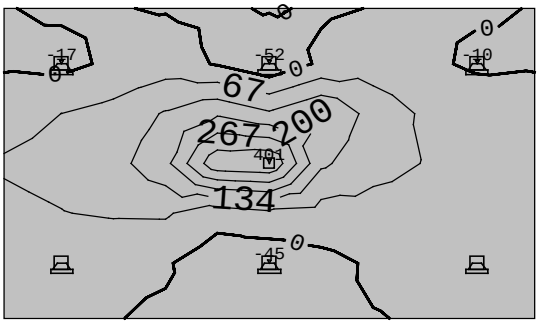
Nivo: [0.00 m]
Uticaji u ploči: max My= 264 / min My= -32 kNm/m

Opt. 3: Pokretno



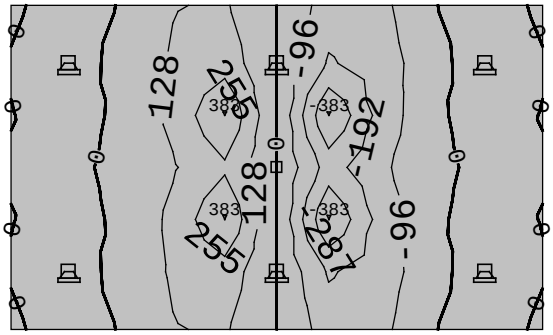
Nivo: [0.00 m]
Uticaji u ploči: max Mx= 429 / min Mx= -34 kNm/m

Opt. 3: Pokretno



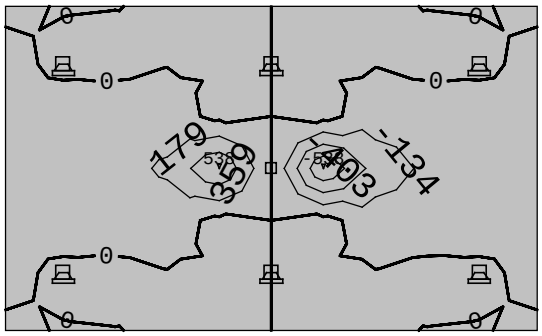
Nivo: [0.00 m]
Uticaji u ploči: max My= 401 / min My= -52 kNm/m

Opt. 4: Sy



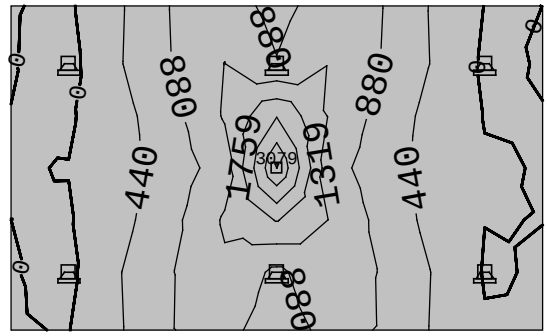
Nivo: [0.00 m]
Uticaji u ploči: max Mx= 383 / min Mx= -383 kNm/m

Opt. 4: Sy



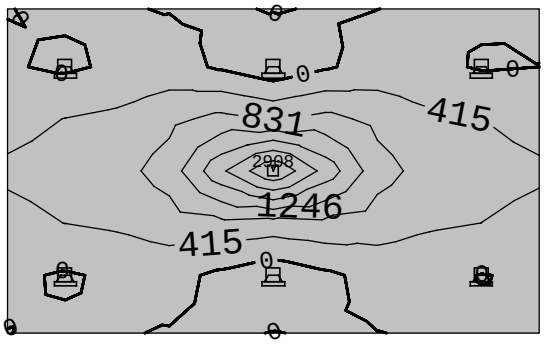
Nivo: [0.00 m]
Uticaji u ploči: max My= 538 / min My= -538 kNm/m

Opt. 9: [Anv] 5-8



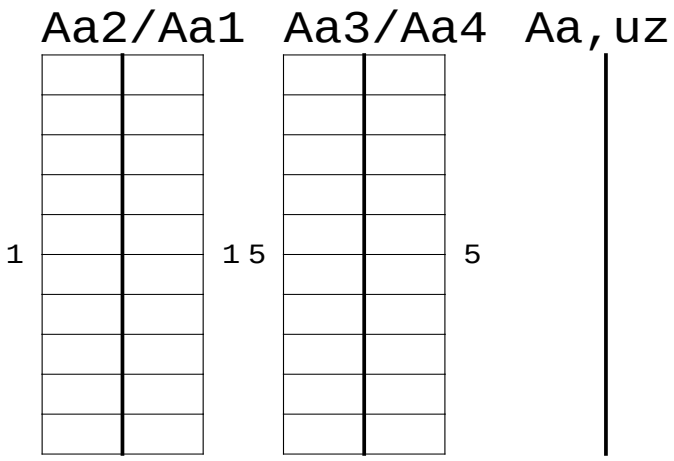
Nivo: [0.00 m]
Uticaji u ploči: max Mx= 3079 / min Mx= 0 kNm/m

Opt. 9: [Anv] 5-8



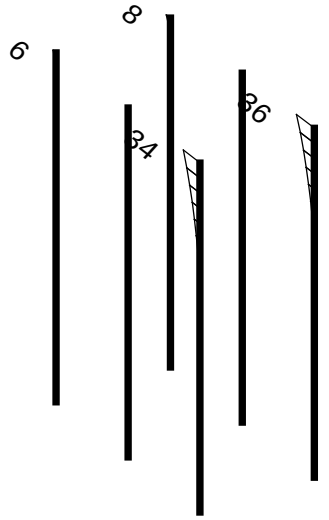
Nivo: [0.00 m]
Uticaji u ploči: max My= 2908 / min My= 0 kNm/m

Design (concrete)



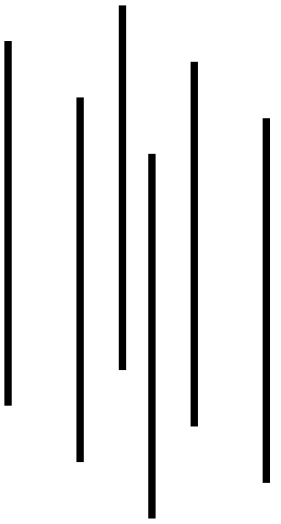
Beam reinforcement: (161-217)

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500



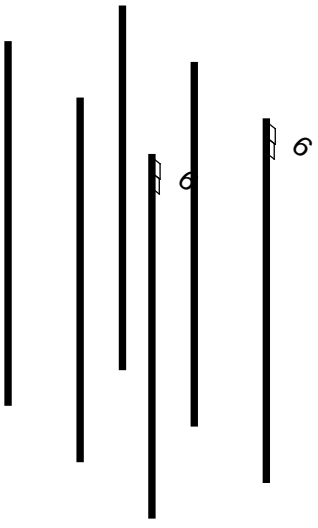
Group: Sipovi
Beam reinforcement: Aa2/Aa1

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500



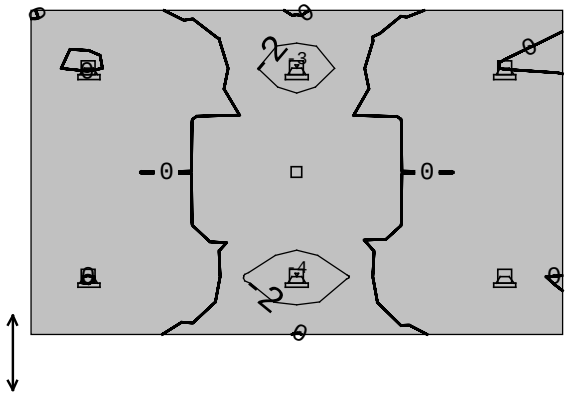
Group: Sipovi
Beam reinforcement: Aa3/Aa4

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500



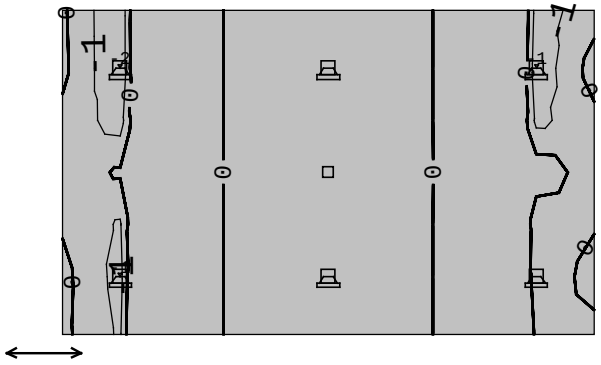
Group: Sipovi
Beam reinforcement: Aa,br

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500, a=7.00 cm



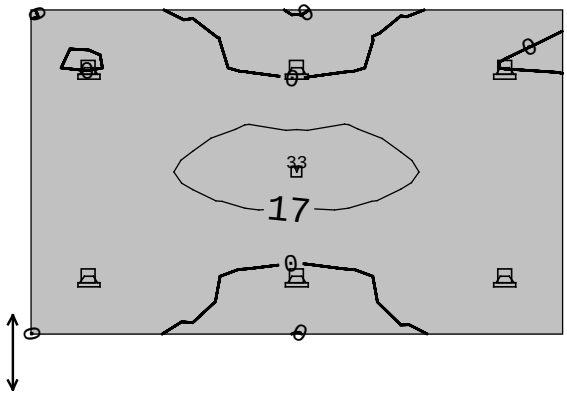
Level: [0.00 m]
Aa - top zone - Direction 2 - max Aa2,u= -4 cm²/m

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500, a=7.00 cm



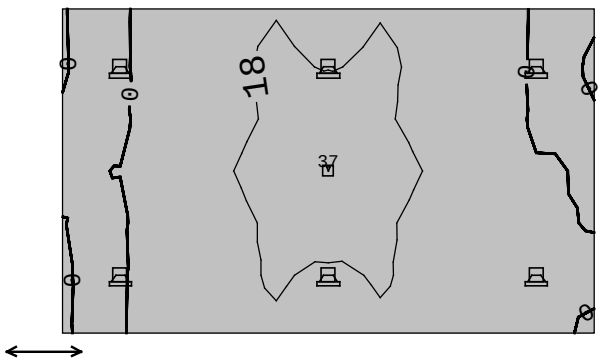
Level: [0.00 m]
Aa - top zone - Direction 1 - max Aa1,u= -2 cm²/m

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500, a=7.00 cm



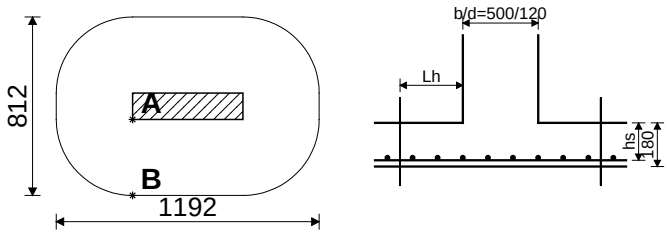
Level: [0.00 m]
Aa - bottom zone - Direction 2 - max Aa2,d= 33 cm²/m

Governing load: 5-8
SRPS EN 1992-1-1, C25/30, B500, a=7.00 cm



Level: [0.00 m]
Aa - bottom zone - Direction 1 - max Aa1,d= 37 cm²/m

Slab punching verification
SRPS EN 1992-1-1
C25/30



CHECK AT THE FACE OF THE COLUMN

Column force (Design)	N =	11574	kN
Eccentricity factor	β =	1.500	
Maximal shear stress (point A)	ved =	0.809	MPa
Slab thickness	d,pl =	1.800	m
Effective depth of the slab	hs =	1.730	m
Characteristic compressive cylinder strength of concrete	fck =	25.000	MPa
Design value of concrete compressive strength	fcd =	14.167	MPa
Factor	v =	0.540	
Factor	γc =	1.500	
Factor	α,cc =	0.850	
Design value of the maximum shear force	vRd,max = 0.40×v×fcd =	3.060	MPa

Condition: ved <= vRd,max (0.81 <= 3.06)
The criteria is satisfied.

CHECK AT THE CRITICAL PERIMETER 1. (Lh = 3.46m from the column)

Column force (Design)	N =	11574	kN
Eccentricity factor	β =	1.500	
Maximal shear stress (point B)	ved =	0.294	MPa
Slab thickness	d,pl =	1.800	m
Effective depth of the slab	hs =	1.730	m
Length of the critical perimeter	u1 =	34.140	m
Characteristic compressive cylinder strength of concrete	fck =	25.000	MPa
Design value of concrete compressive strength	fcd =	14.167	MPa
Factor	v =	0.540	
Factor	γc =	1.500	
Factor	α,cc =	0.850	
Design value of the maximum shear force	vRd,max = 0.40×v×fcd =	3.060	MPa

Condition: ved <= vRd,max (0.29 <= 3.06)
The criteria is satisfied.

Existing slab reinforcement			
Reinforcement ratio - direction 2	ρ,1 =	0.284	%
Reinforcement ratio - direction 2	ρ,2 =	0.284	%
Mean value of reinforcement ratio	ρl =	0.284	%
Factor	CRd,c =	0.120	
Factor	K1 =	0.100	
Factor	k,vmin=	0.035	

Factor	vmin=	0.271	
Normal concrete stress	σcp =	-0.000	MPa

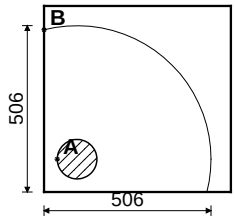
Punching shear resistance of slab without shear reinforcement

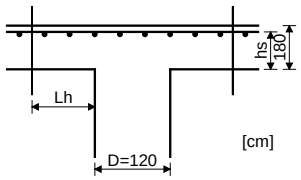
vRd,c =	0.309	MPa

Condition: ved <= vRd,c (0.29 <= 0.31)

The criteria is satisfied - additional shear reinforcement is not required.

Slab punching verification
SRPS EN 1992-1-1
C25/30





CHECK AT THE FACE OF THE COLUMN

Column force (Design)	N =	4371.0	kN
Eccentricity factor	β =	1.500	
Maximal shear stress (point A)	ved =	1.005	MPa
Slab thickness	d,pl =	1.800	m
Effective depth of the slab	hs =	1.730	m
Characteristic compressive cylinder strength of concrete	fck =	25.000	MPa
Design value of concrete compressive strength	fcd =	14.167	MPa
Factor	v =	0.540	
Factor	γc =	1.500	
Factor	α,cc =	0.850	
Design value of the maximum shear force	vRd,max = 0.40×v×fcd =	3.060	MPa

Condition: ved <= vRd,max (1.01 <= 3.06)
The criteria is satisfied.

CHECK AT THE CRITICAL PERIMETER 1. (Lh = 3.46m from the column)

Column force (Design)	N =	4371.0	kN
Eccentricity factor	β =	1.500	
Maximal shear stress (point B)	ved =	0.451	MPa
Slab thickness	d,pl =	1.800	m
Effective depth of the slab	hs =	1.730	m
Length of the critical perimeter	u1 =	8.398	m
Characteristic compressive cylinder strength of concrete	fck =	25.000	MPa
Design value of concrete compressive strength	fcd =	14.167	MPa
Factor	v =	0.540	
Factor	γc =	1.500	
Factor	α,cc =	0.850	
Design value of the maximum shear force	vRd,max = 0.40×v×fcd =	3.060	MPa

Condition: ved <= vRd,max (0.45 <= 3.06)
The criteria is satisfied.

Existing slab reinforcement			
Reinforcement ratio - direction 2	ρ,1 =	0.284	%
Reinforcement ratio - direction 2	ρ,2 =	0.284	%
Mean value of reinforcement ratio	ρl =	0.284	%
Factor	CRd,c =	0.120	
Factor	K1 =	0.100	
Factor	k,vmin=	0.035	

Factor	vmin=	0.271	
Normal concrete stress	σcp =	-0.000	MPa

Punching shear resistance of slab without shear reinforcement

	vRd,c =	0.309	MPa

Condition: ved <= vRd,c (0.45 <= 0.31)
Shear reinforcements is required.

Condition: ved / vRd,c <= kmax (0.45 / 0.31 = 1.46 <= 1.50)
The criteria is satisfied.

Punching shear reinforcement B500

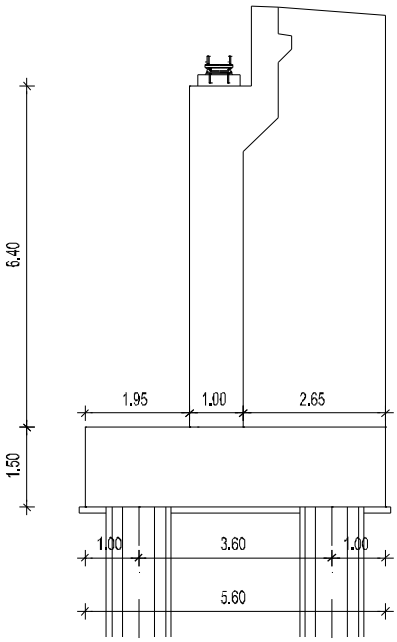
Inclination angle	α =	90°	
Bar spacing in radial direction	sr =	15.000	cm

Required area of shear reinforcement **Asw = 3.686 cm2**

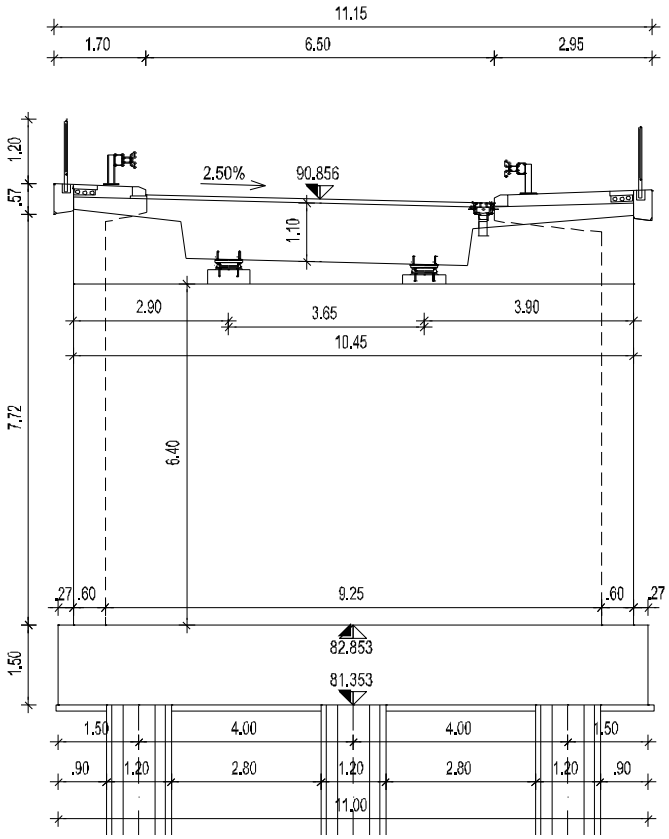
4.7. OBALNI STUB

ABUTMENT

4.7.1 **Диспозиција /** General arrangement



Подужни пресек / longitudinal section



Попречни пресек / cross section

4.7.2 **Анализа оптерецења /** Load analyses

4.7.2.1 **Сопствена тежина** / Self weight

Сопствена тежина свих елемената је узета у обзир у прорачуну аутоматски у програмском пакету.

Self weight of all elements will be taken into account automaticaly by design software.

Парапет /Parapet **w**all **,** d = 50 cm

Крило / Wing wall **,** d = 50 cm

Зид / Wall , d = 100 cm

Темељ / Foundation , d = 150 cm

Шипови / Piles **,** Φ120 cm

4.7.2.2 **Стално оптерећење /** Dead load

Коловозна плоча / Deck

Реакције преузете из RM софтвера / Reactions taken from RM software

R1 = 893 kN

R2 = 893 kN

4.7.2.3 **Додатно стално оптерећење /** Superimposed load

Разматрана су следећа оптерећења / The following loads are considered :

- **Асфалт /**Asphalt
- **Хидроизолација /** Waterproofing
- **Пешачка стаза** / Foot path
- **Ивичњак /** Curb
- **Ел. Одбојна ограда /** Steel safety barrier
- **Пешачка ограда** / railing

Реакције преузете из RM софтвера / Reactions taken from RM software

R1 = 366 kN

R2 = 366 kN

4.7.2.4 Притисак тла / Earth pressure

Притисак тла у миру / earth pressure at rest

pzh = (1-sinφ) x γ x h = ko x γ x h

φ = 35

Прорачун по ULS-u / Design at ULS

tan φd = tanφk/γ_{φ} = tan35/1.25 = 0.46

φd = arctan0.46 = 24.79^{o}

ko = 1-sinφk = 0.581

γz = 20 kN/m3

Притисак на парапет / pressure on the parapet wall

h = 0.0 m → pzh = 0 kN/m2

h = 1.5 m → pzh = 0.581 x 20 x 1.5 = 18 kN/m2

Притисак на зид / pressure on the wall

h = 1.7 m → pzh = 0.581 x 20 x 1.5 = 18 kN/m2

h = 5.7 m → pzh = 0.581 x 20 x 7.9 = 92 kN/m2

4.7.2.5 Возило на објекту / Traffic load on the structure

Реакције преузете из RM софтвера / Reactions taken from RM software

TS

R1 = 538 kN

R2 = 416 kN

UDL

R1 = 181 kN

R2 = 88 kN

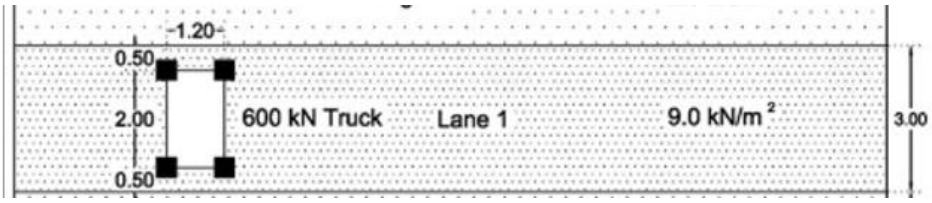
Укупно / total

R= 583 +284+122= 989kN

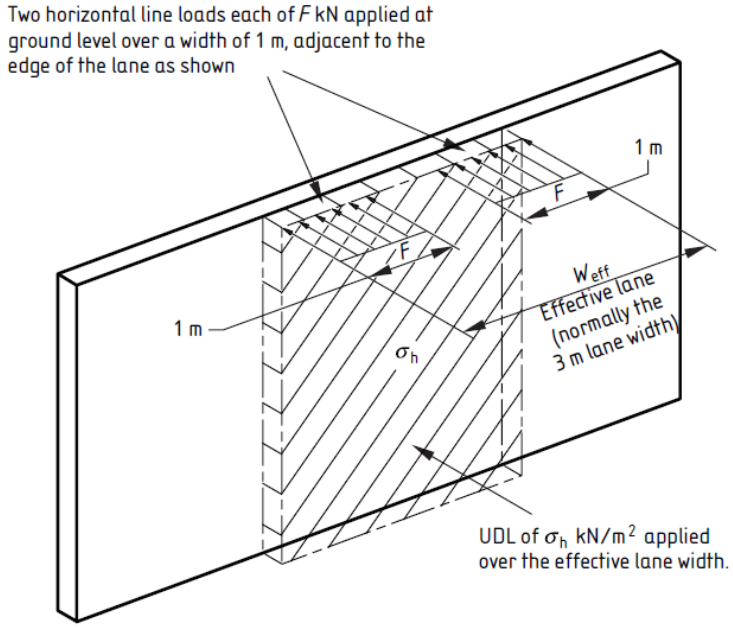
4.7.2.6 Возило на насипу / Traffic load on embankment

Двоосовински тандем систем (TS) концентрисаних сила / Tandem system (including two axles) (TS)

Прва трака / First lane Q_{1k}= 1.0 x 2 x 300 kN= 600 kN



Распростирање оптерећења / Load distribution



F = 330 x ko x Lf = 330 x 0.581 x 1.0 = 192 kN/m

σ = 20 x ko x R x Lf , ko = 0.581 , R = 3.0/w = 1.0 , Lf = 1.0

σ = 20 x 0.581 x 1.0 x 1.0 = 6.75 kN/m2

4.7.3 **Статички модел /** Static model

Tabela materijala

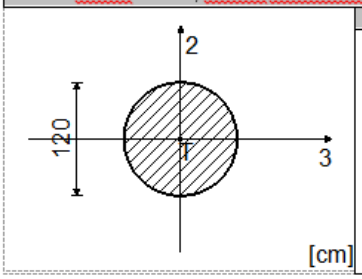
No	Naziv materijala	E[kN/m2]	μ	γ[kN/m3]	αt[1/C]	Em[kN/m2]	μm
1	Beton MB 30	3.150e+7	0.20	25.00	1.000e-5	3.150e+7	0.20
2	Beton MB 30	3.150e+7	0.20	0.00	1.000e-5	3.150e+7	0.20

Setovi ploča

No	d[m]	e[m]	Materijal	Tip proračuna	Ortotropija	E2[kN/m2]	G[kN/m2]	α
<2>	1.500	0.750	1	Tanka ploča	Izotropna			
<5>	0.500	0.250	1	Tanka ploča	Izotropna			
<6>	1.000	0.500	1	Tanka ploča	Izotropna			

Setovi greda

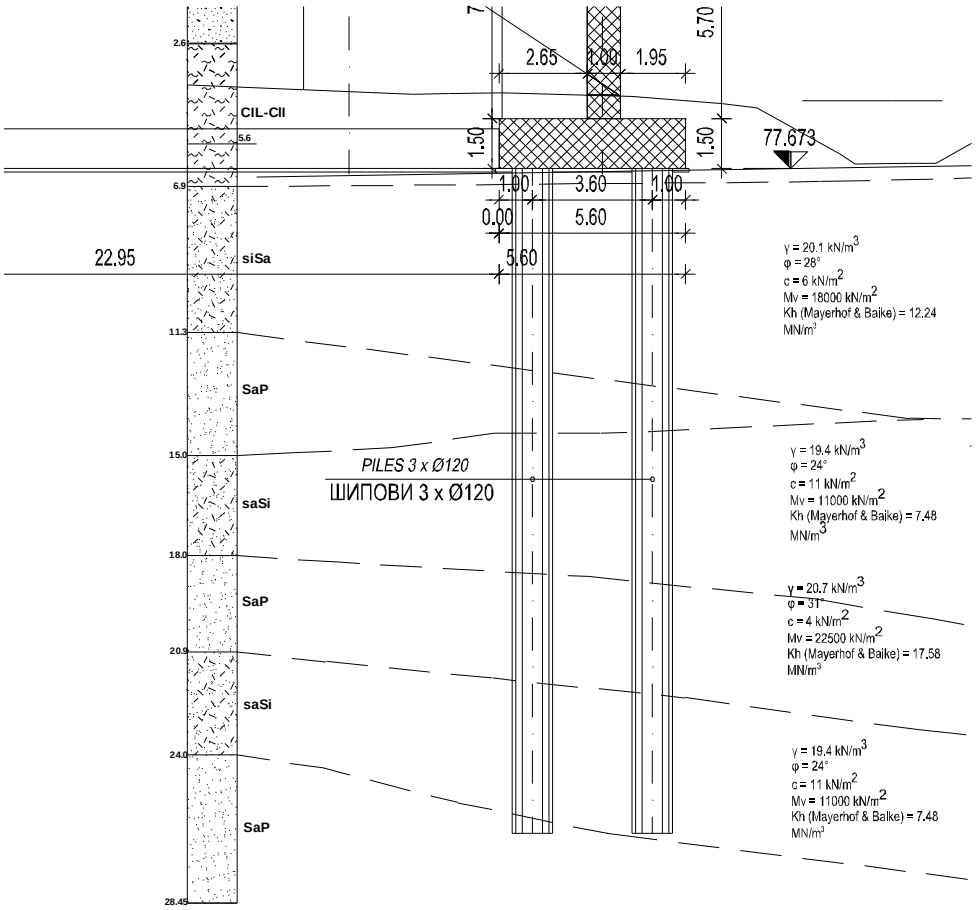
Set: 1 Presek: D=120, Fiktivna ekscentričnost



Mat.	A1	A2	A3	I1	I2	I3
2 - Beton MB 30	1.131e+0	1.018e+0	1.018e+0	2.036e-1	1.018e-1	1.018e-1

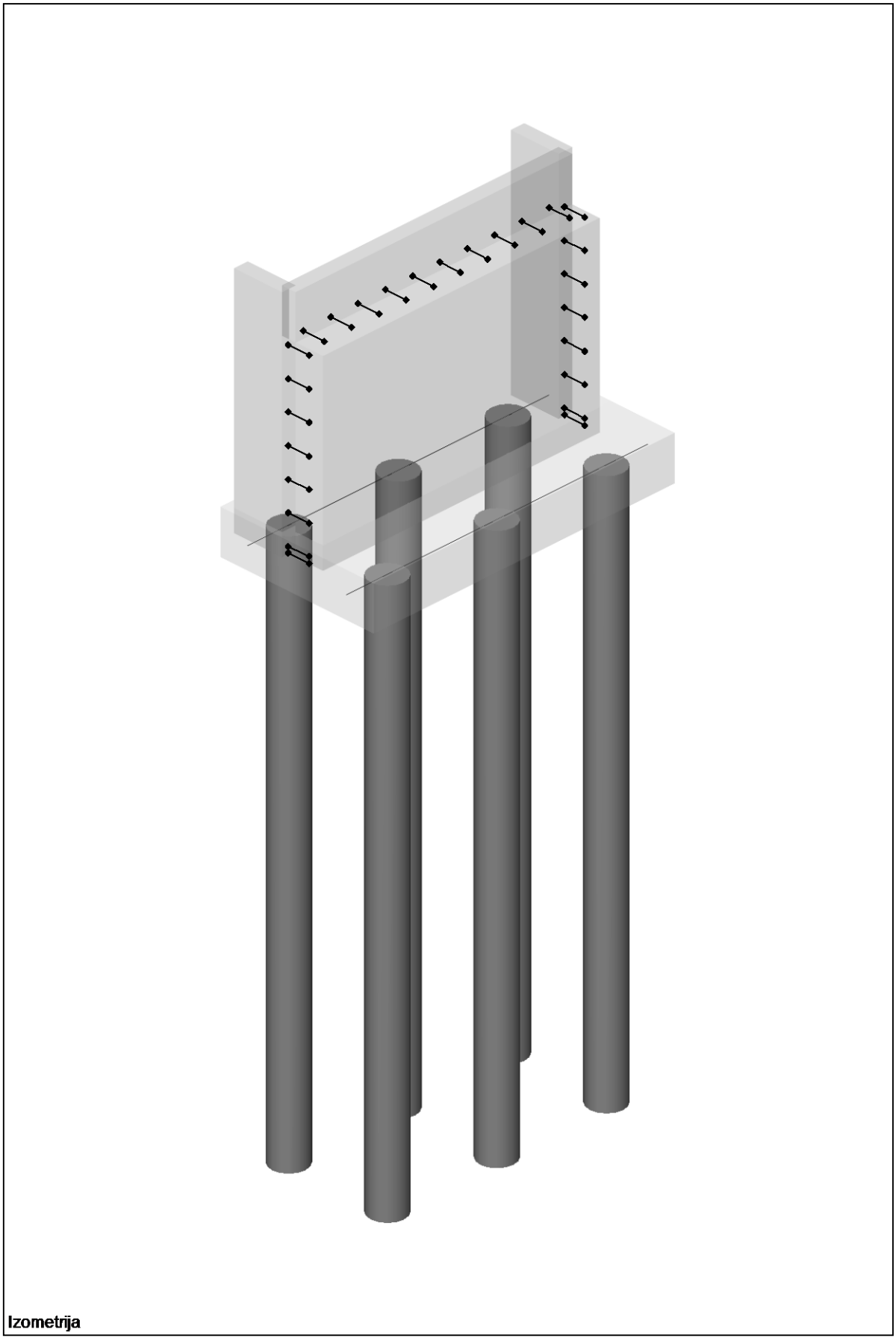
Linear support sets

Set	K,R1	K,R2	K,R3	K,M1	Soil [m]
1		1.540e+4	1.540e+4		
2		9.000e+3	9.000e+3		
3		2.100e+4	2.100e+4		



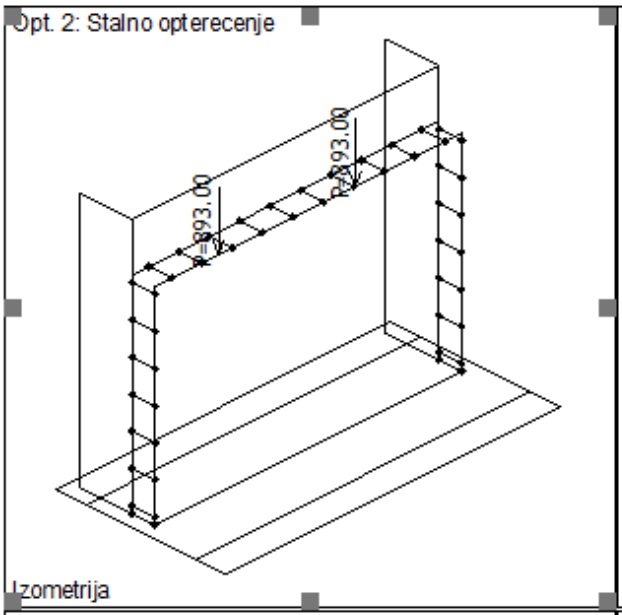
Linear support sets Dynamic load

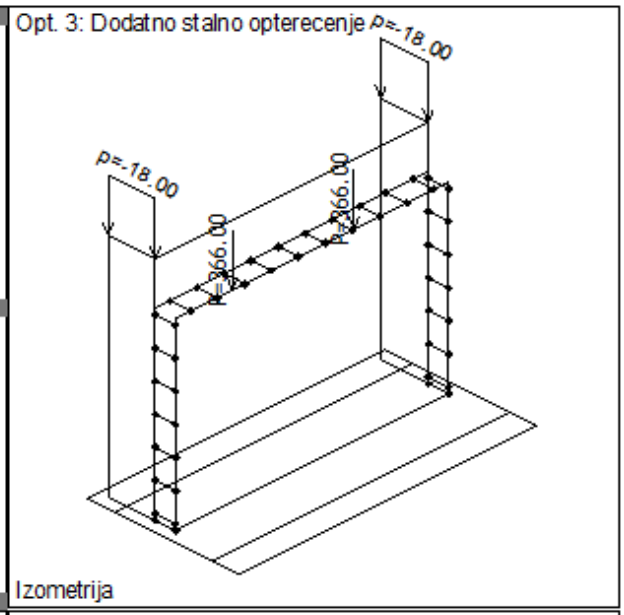
Set	K,R1	K,R2	K,R3	K,M1	Soil [m]
4		3.000e+4	3.000e+4		
5		1.800e+4	1.800e+4		
6		4.200e+4	4.200e+4		

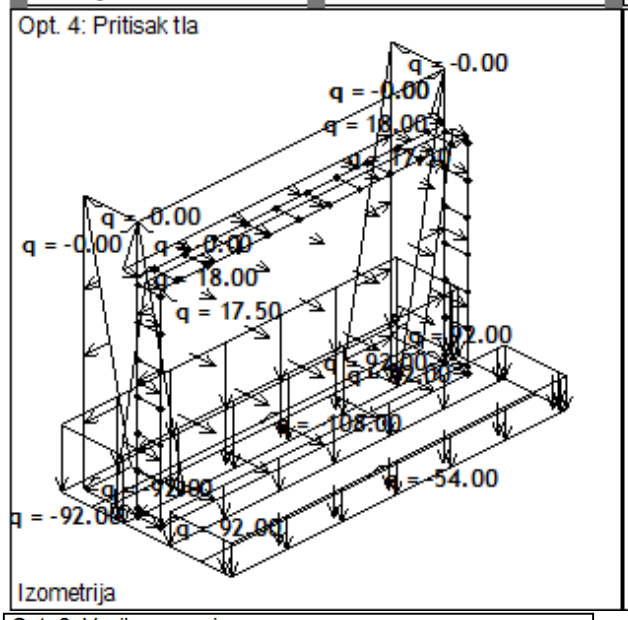


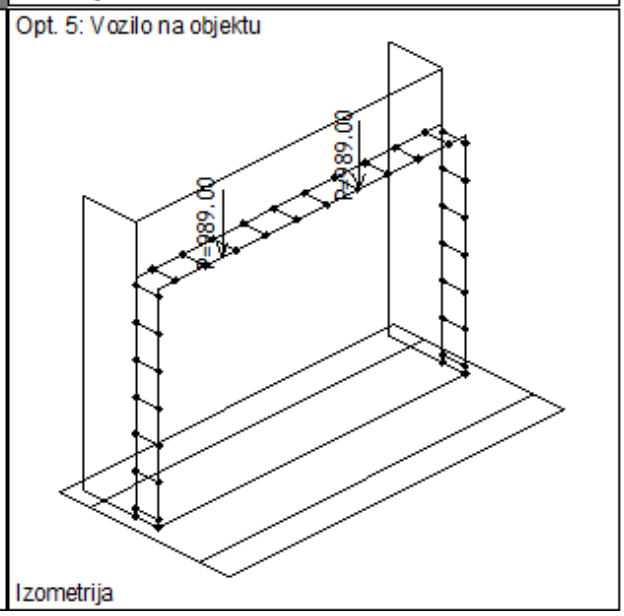
Izometrija

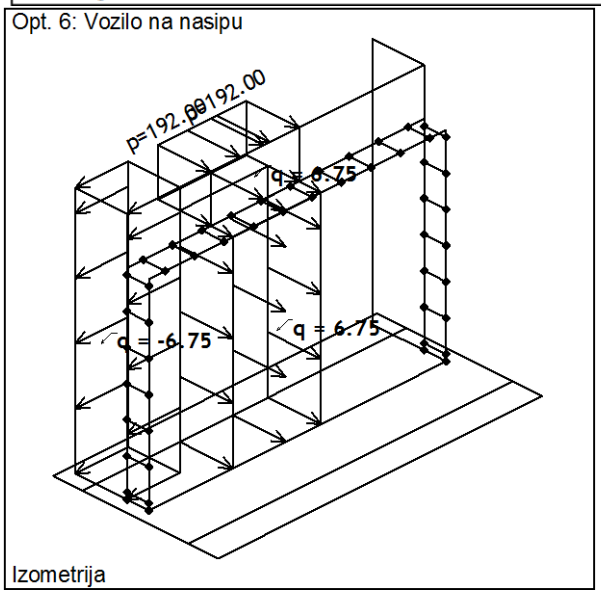
4.7.4 **Оптерећења /** Loads





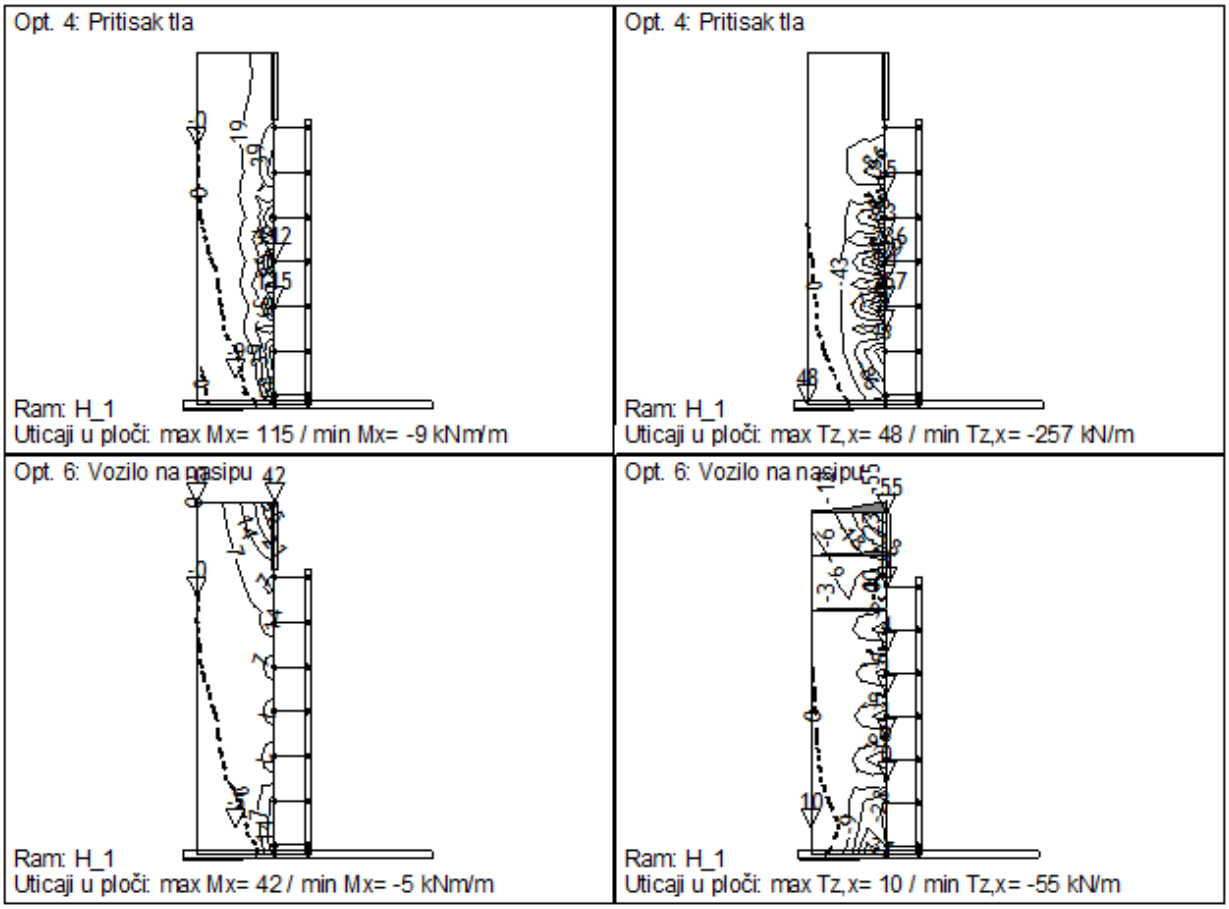






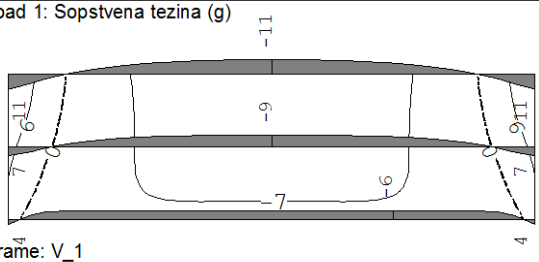
4.7.5 **Пресечне силе и деформације /** Internal forces and deformations

4.7.5.1 **Крило/** Wing wall



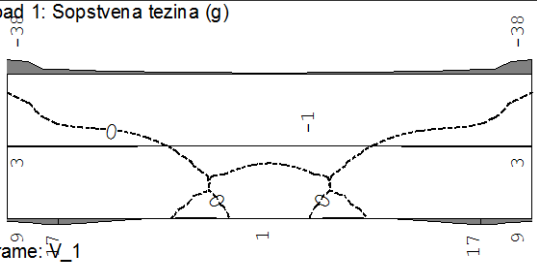
4.7.5.2 **Парапет/** Parapet **w**all

Load 1: Sopstvena tezina (g)



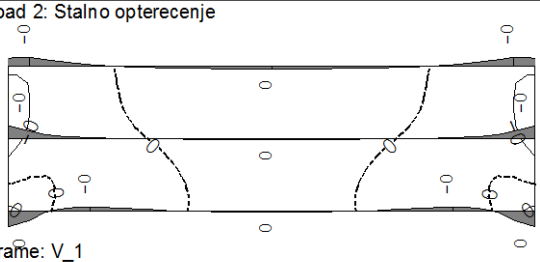
Frame: V_1
Slab Results: max Mx= 17 / min Mx= -27 kNm/m

Load 1: Sopstvena tezina (g)



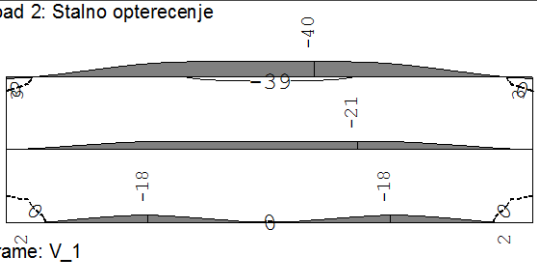
Frame: V_1
Slab Results: max Nx= 75 / min Nx= -228 kN/m

Load 2: Stalno opterecenje



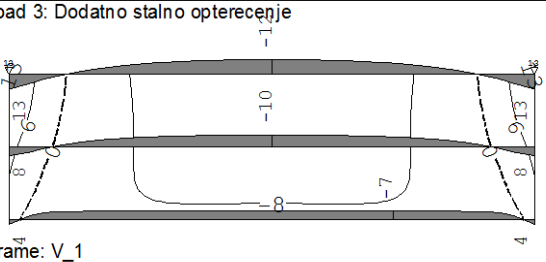
Frame: V_1
Slab Results: max Mx= 1 / min Mx= -0 kNm/m

Load 2: Stalno opterecenje



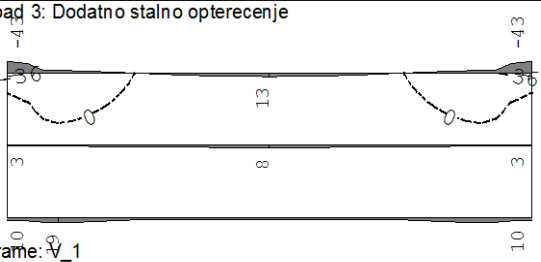
Frame: V_1
Slab Results: max Nx= 136 / min Nx= -154 kN/m

Load 3: Dodatno stalno opterecenje



Frame: V_1
Slab Results: max Mx= 19 / min Mx= -31 kNm/m

Load 3: Dodatno stalno opterecenje

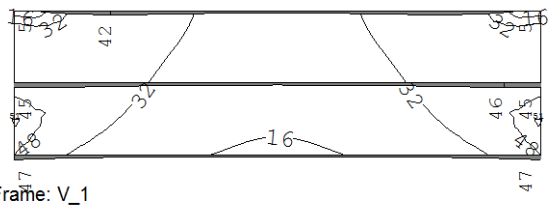


Frame: V_1
Slab Results: max Nx= 50 / min Nx= -178 kN/m

Load 4: Pritisak tla

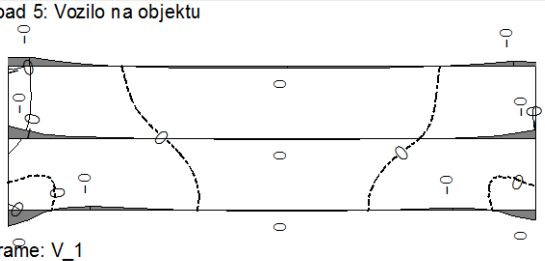
Frame: V_1
Slab Results: max Mx= 101 / min Mx= -50 kNm/m

Load 4: Pritisak tla



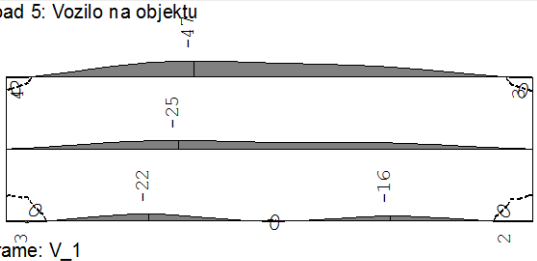
Frame: V_1
Slab Results: max Nx= 63 / min Nx= -37 kN/m

Load 5: Vozilo na objektu



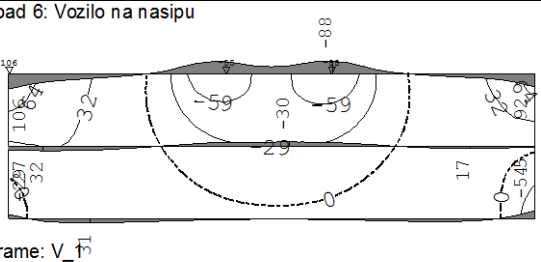
Frame: V_1
Slab Results: max Mx= 1 / min Mx= -0 kNm/m

Load 5: Vozilo na objektu



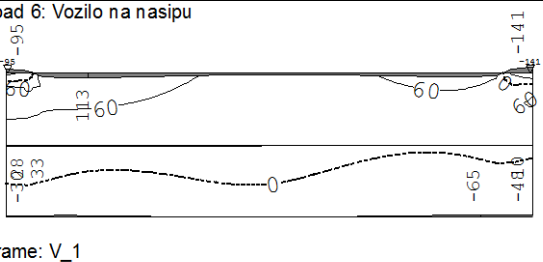
Frame: V_1
Slab Results: max Nx= 173 / min Nx= -191 kN/m

Load 6: Vozilo na nasipu



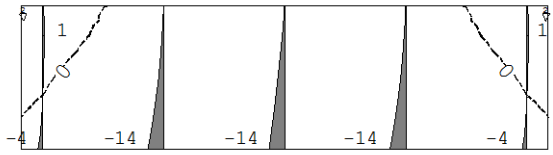
Frame: V_1
Slab Results: max Mx= 128 / min Mx= -88 kNm/m

Load 6: Vozilo na nasipu



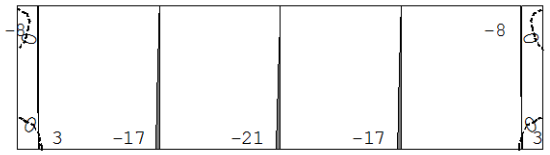
Frame: V_1
Slab Results: max Nx= 298 / min Nx= -146 kN/m

Load 1: Sopstvena tezina (g)



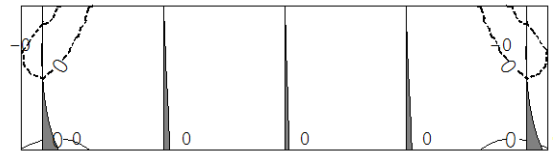
Frame: V_1
Slab Results: max My= 2 / min My= -108 kNm/m

Load 1: Sopstvena tezina (g)



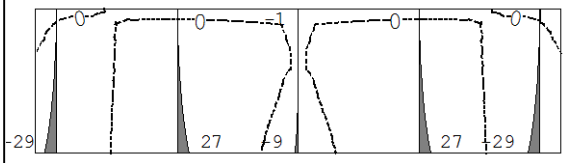
Frame: V_1
Slab Results: max Ny= 174 / min Ny= -451 kN/m

Load 2: Stalno opterecenje



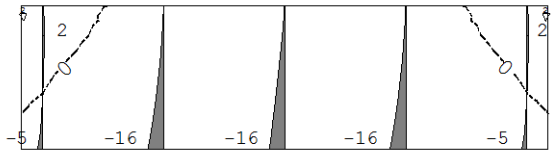
Frame: V_1
Slab Results: max My= 1 / min My= -1 kNm/m

Load 2: Stalno opterecenje



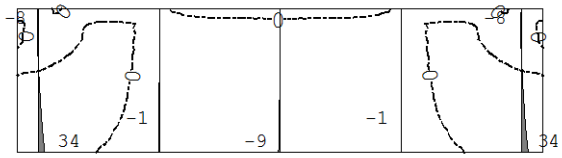
Frame: V_1
Slab Results: max Ny= 336 / min Ny= -327 kN/m

Load 3: Dodatno stalno opterecenje



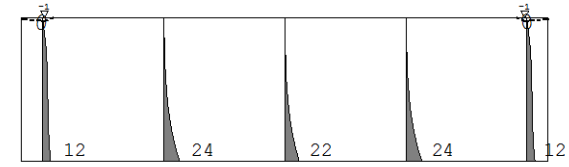
Frame: V_1
Slab Results: max My= 2 / min My= -123 kNm/m

Load 3: Dodatno stalno opterecenje



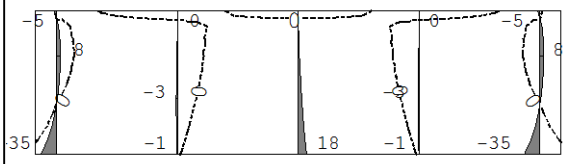
Frame: V_1
Slab Results: max Ny= 235 / min Ny= -276 kN/m

Load 4: Pritisak tla



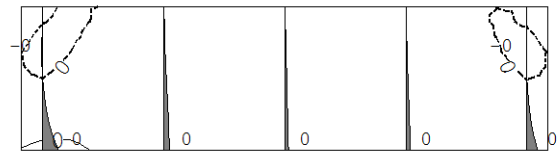
Frame: V_1
Slab Results: max My= 399 / min My= -1 kNm/m

Load 4: Pritisak tla



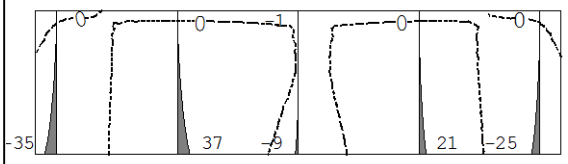
Frame: V_1
Slab Results: max Ny= 160 / min Ny= -278 kN/m

Load 5: Vozilo na objektu



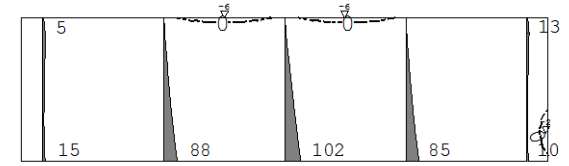
Frame: V_1
Slab Results: max My= 1 / min My= -1 kNm/m

Load 5: Vozilo na objektu



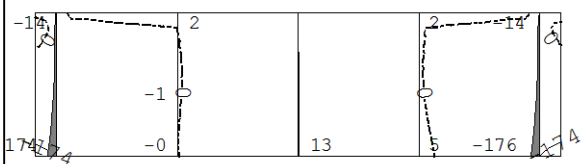
Frame: V_1
Slab Results: max Ny= 433 / min Ny= -402 kN/m

Load 6: Vozilo na nasipu



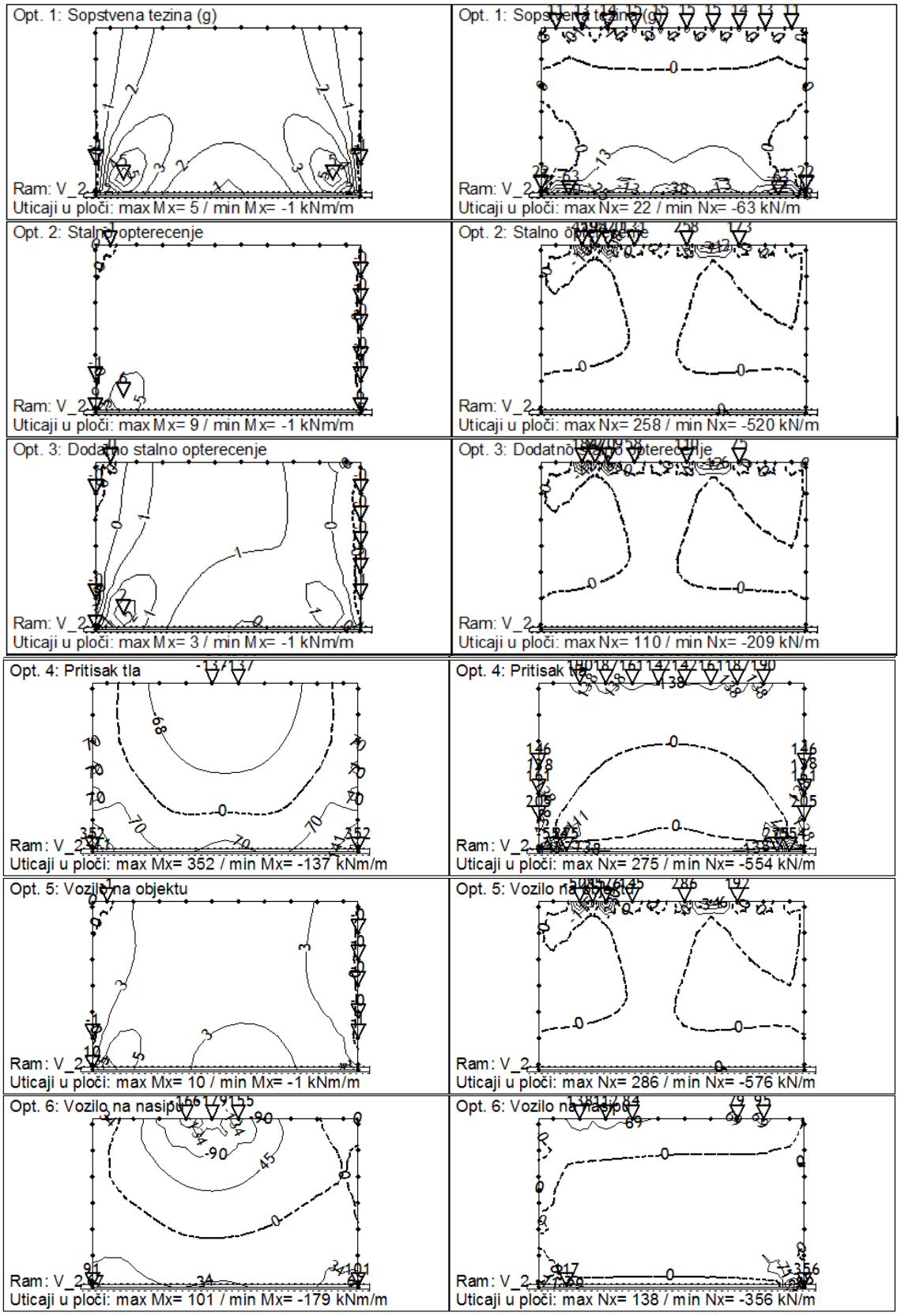
Frame: V_1
Slab Results: max My= 616 / min My= -6 kNm/m

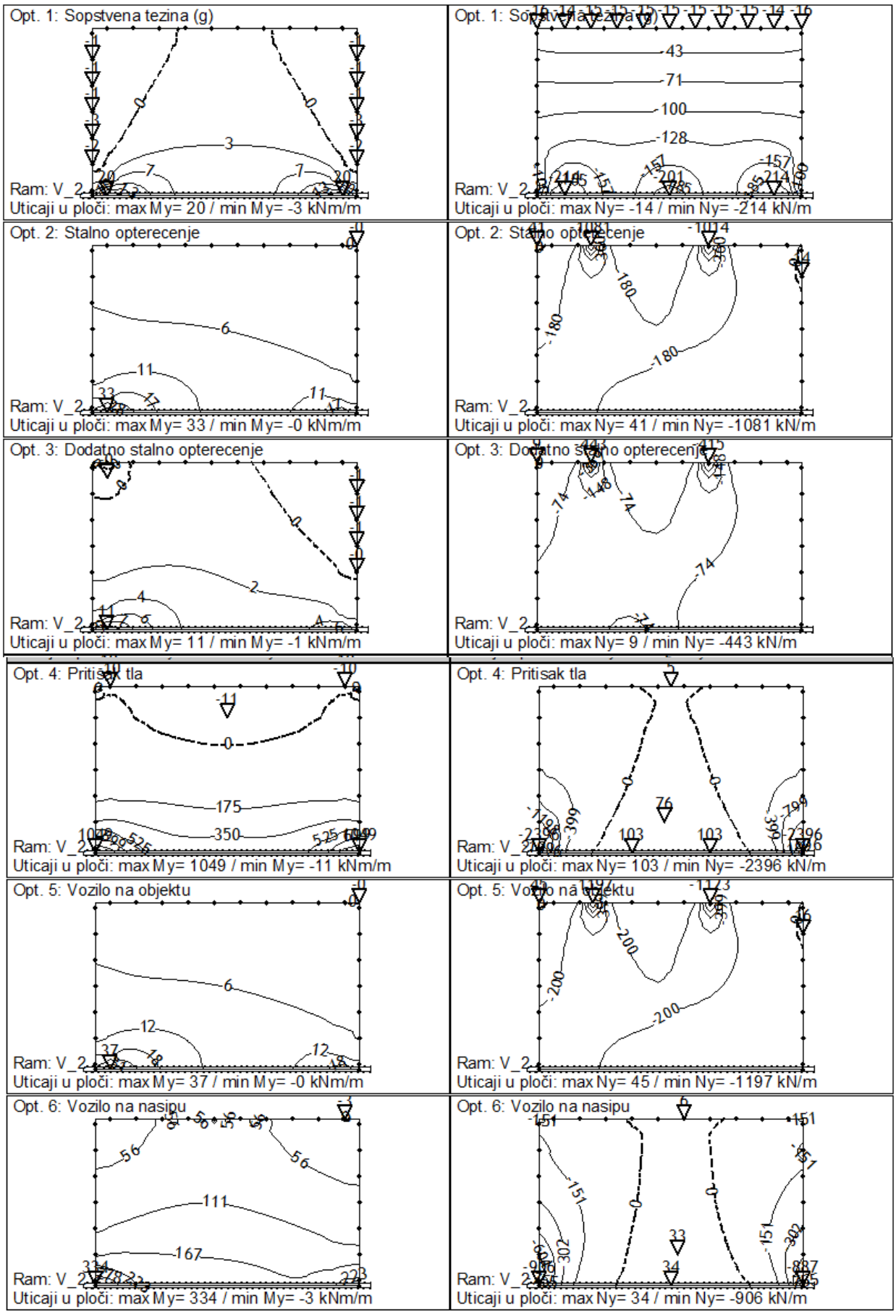
Load 6: Vozilo na nasipu



Frame: V_1
Slab Results: max Ny= 466 / min Ny= -868 kN/m

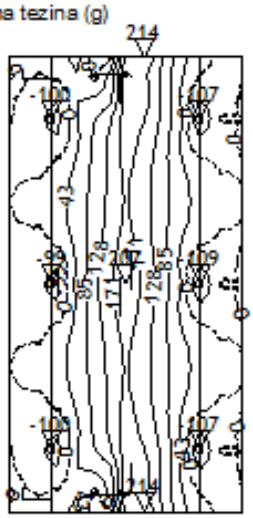
4.7.5.3 Зид / Wall , d = 100 cm




Opt. 1: Sopstvena tezina (g)
Ram: V_2
Uticaji u ploči: max My= 20 / min My= -3 kNm/m
Opt. 1: Sopstvena tezina (g)
Ram: V_2
Uticaji u ploči: max Ny= -14 / min Ny= -214 kN/m
Opt. 2: Stalno opterecenje
Ram: V_2
Uticaji u ploči: max My= 33 / min My= -0 kNm/m
Opt. 2: Stalno opterecenje
Ram: V_2
Uticaji u ploči: max Ny= 41 / min Ny= -1081 kN/m
Opt. 3: Dodatno stalno opterecenje
Ram: V_2
Uticaji u ploči: max My= 11 / min My= -1 kNm/m
Opt. 3: Dodatno stalno opterecenje
Ram: V_2
Uticaji u ploči: max Ny= 9 / min Ny= -443 kN/m
Opt. 4: Pritisak tla
Ram: V_2
Uticaji u ploči: max My= 1049 / min My= -11 kNm/m
Opt. 4: Pritisak tla
Ram: V_2
Uticaji u ploči: max Ny= 103 / min Ny= -2396 kN/m
Opt. 5: Vozilo na objektu
Ram: V_2
Uticaji u ploči: max My= 37 / min My= -0 kNm/m
Opt. 5: Vozilo na objektu
Ram: V_2
Uticaji u ploči: max Ny= 45 / min Ny= -1197 kN/m
Opt. 6: Vozilo na nasipu
Ram: V_2
Uticaji u ploči: max My= 334 / min My= -3 kNm/m
Opt. 6: Vozilo na nasipu
Ram: V_2
Uticaji u ploči: max Ny= 34 / min Ny= -906 kN/m

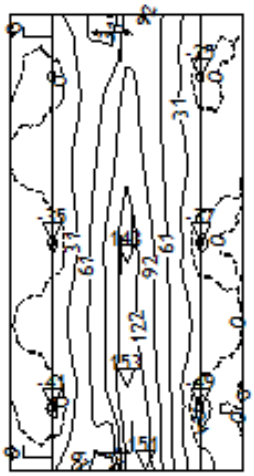
4.7.5.4 **Темељ /** Foundation

Opt. 1: Sopstvena tezina (g)



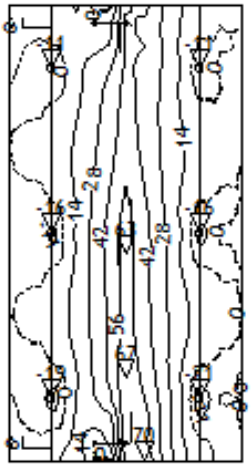
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 214 / min Mx= -109 kNm/m

Opt. 2: Stalno opterecenje



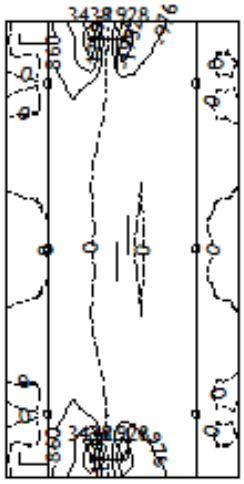
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 153 / min Mx= -49 kNm/m

Opt. 3: Dodatno stalno opterecenje



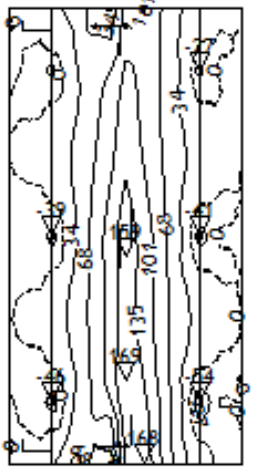
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 70 / min Mx= -21 kNm/m

Opt. 4: Pritisak tla



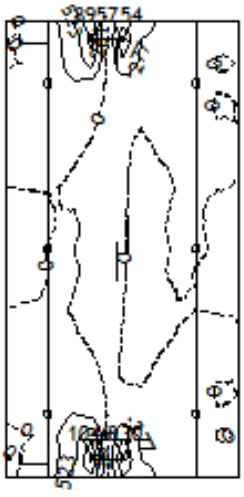
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 3438 / min Mx= -2928 kNm/m

Opt. 5: Vozilo na objektu



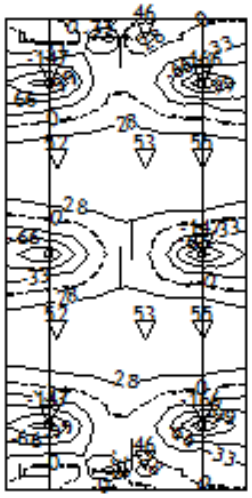
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 169 / min Mx= -54 kNm/m

Opt. 6: Vozilo na nasipu



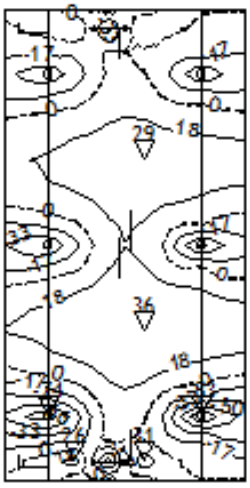
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 1046 / min Mx= -830 kNm/m

Opt. 1: Sopstvena tezina (g)



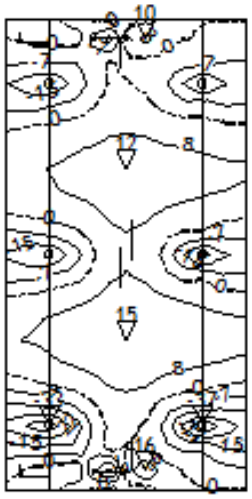
Nivo: [-7.90 m]
Uticaji u ploči: max My= 55 / min My= -166 kNm/m

Opt. 2: Stalno opterecenje



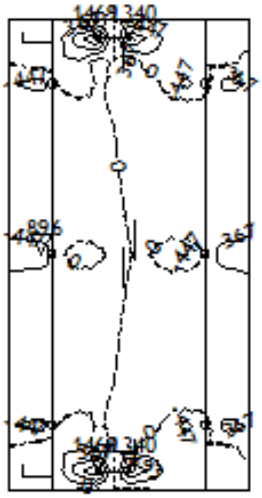
Nivo: [-7.90 m]
Uticaji u ploči: max My= 36 / min My= -83 kNm/m

Opt. 3: Dodatno stalno opterecenje



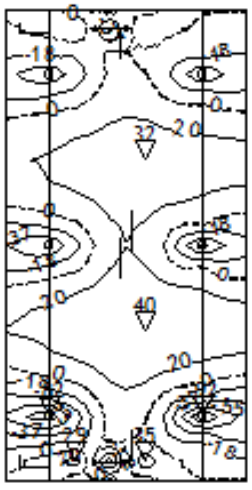
Nivo: [-7.90 m]
Uticaji u ploči: max My= 16 / min My= -37 kNm/m

Opt. 4: Pritisak tla



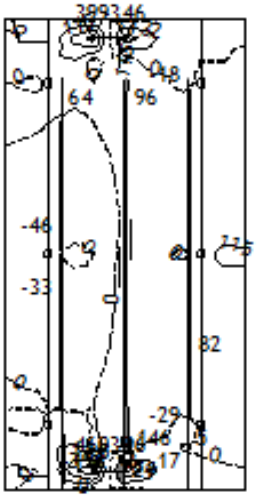
Nivo: [-7.90 m]
Uticaji u ploči: max My= 1469 / min My= -1340 kNm/m

Opt. 5: Vozilo na objektu



Nivo: [-7.90 m]
Uticaji u ploči: max My= 40 / min My= -92 kNm/m

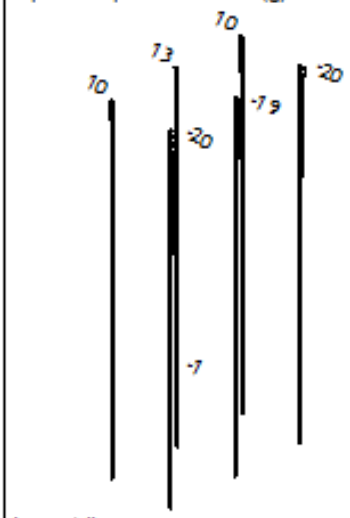
Opt. 6: Vozilo na nasipu



Nivo: [-7.90 m]
Uticaji u ploči: max My= 460 / min My= -396 kNm/m

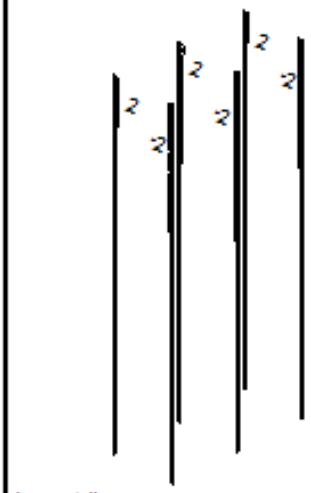
4.7.5.5 **Шипови /** Piles

Opt. 1: Sopstvena tezina (g)



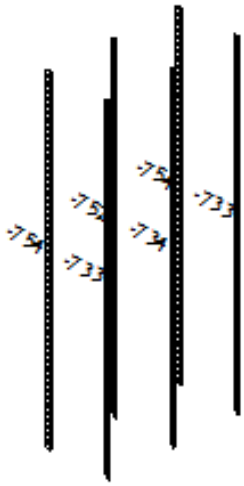
Izometrija
Uticaji u gredi: max M3= 13 / min M3...

Opt. 1: Sopstvena tezina (g)



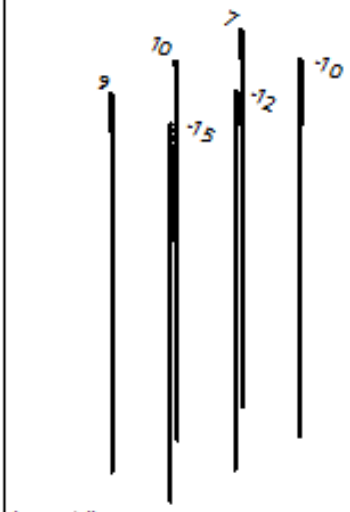
Izometrija
Uticaji u gredi: max T2= 2 / min T2= ...

Opt. 1: Sopstvena tezina (g)



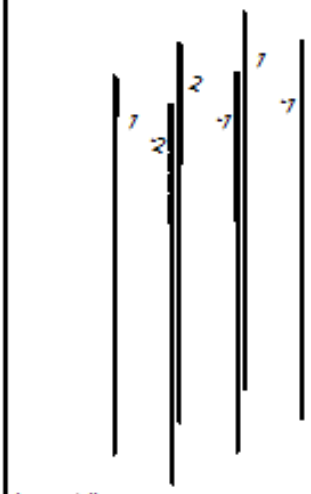
Izometrija
Uticaji u gredi: max N1= -733 / min ...

Opt. 2: Stalno opterecenje



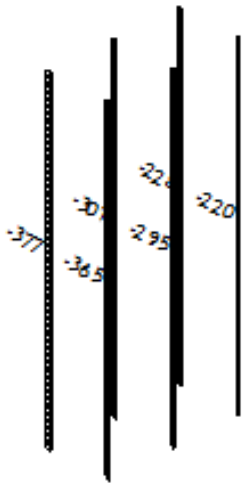
Izometrija
Uticaji u gredi: max M3= 10 / min M3...

Opt. 2: Stalno opterecenje



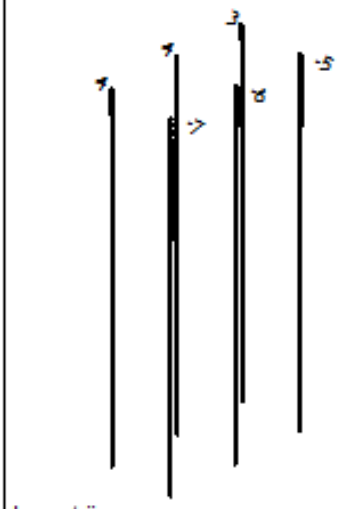
Izometrija
Uticaji u gredi: max T2= 2 / min T2= ...

Opt. 2: Stalno opterecenje



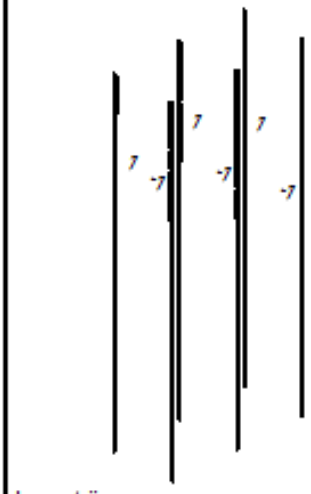
Izometrija
Uticaji u gredi: max N1= -220 / min ...

Opt. 3: Dodatno stalno opterecenje



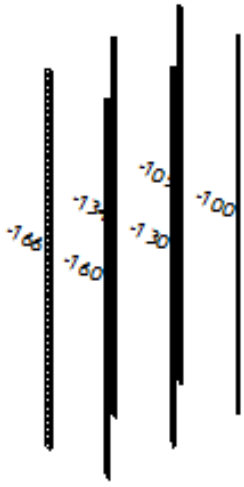
Izometrija
Uticaji u gredi: max M3= 4 / min M3=...

Opt. 3: Dodatno stalno opterecenje



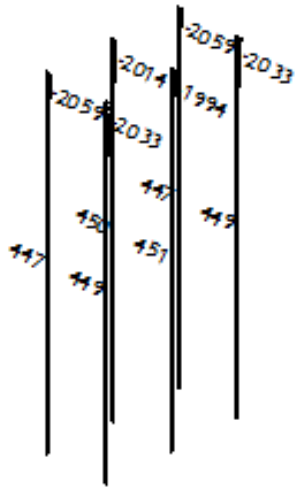
Izometrija
Uticaji u gredi: max T2= 1 / min T2= ...

Opt. 3: Dodatno stalno opterecenje



Izometrija
Uticaji u gredi: max N1= -100 / min ...

Opt. 4: Pritisak tla

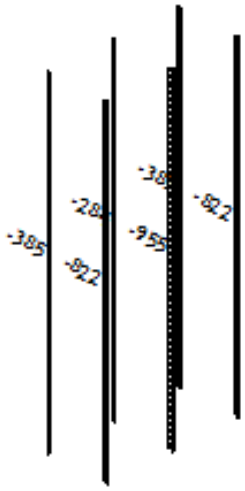


Izometrija
Uticaji u gredi: max M3= 451 / min ...

Opt. 4: Pritisak tla

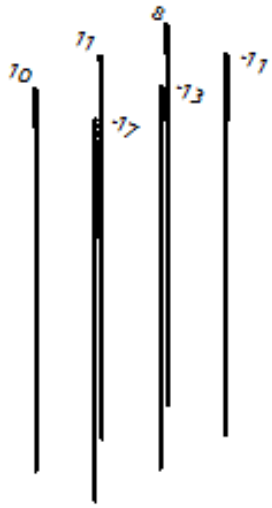
Izometrija
Uticaji u gredi: max T2= 66 / min T2...

Opt. 4: Pritisak tla



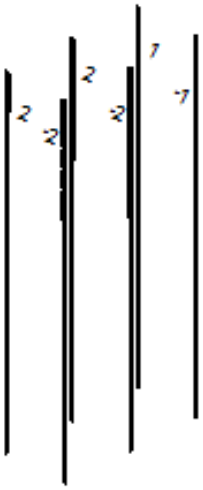
Izometrija
Uticaji u gredi: max N1= -284 / min ...

Opt. 5: Vozilo na objektu



Izometrija
Uticaji u gredi: max M3= 11 / min M3...

Opt. 5: Vozilo na objektu



Izometrija
Uticaji u gredi: max T2= 2 / min T2= ...

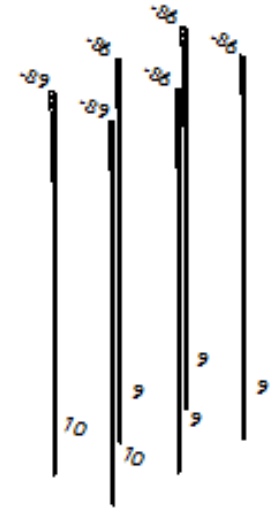
Opt. 5: Vozilo na objektu

Izometrija
Uticaji u gredi: max N1= -244 / min ...

Opt. 6: Vozilo na nasipu

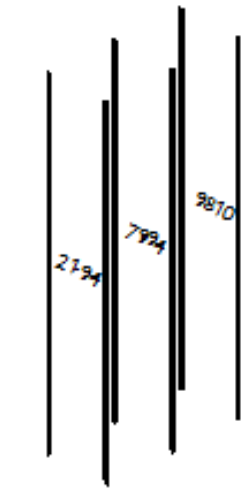
Izometrija
Uticaji u gredi: max M3= 70 / min M3...

Opt. 6: Vozilo na nasipu



Izometrija
Uticaji u gredi: max T2= 10 / min T2...

Opt. 6: Vozilo na nasipu



Izometrija
Uticaji u gredi: max N1= 98 / min N1...

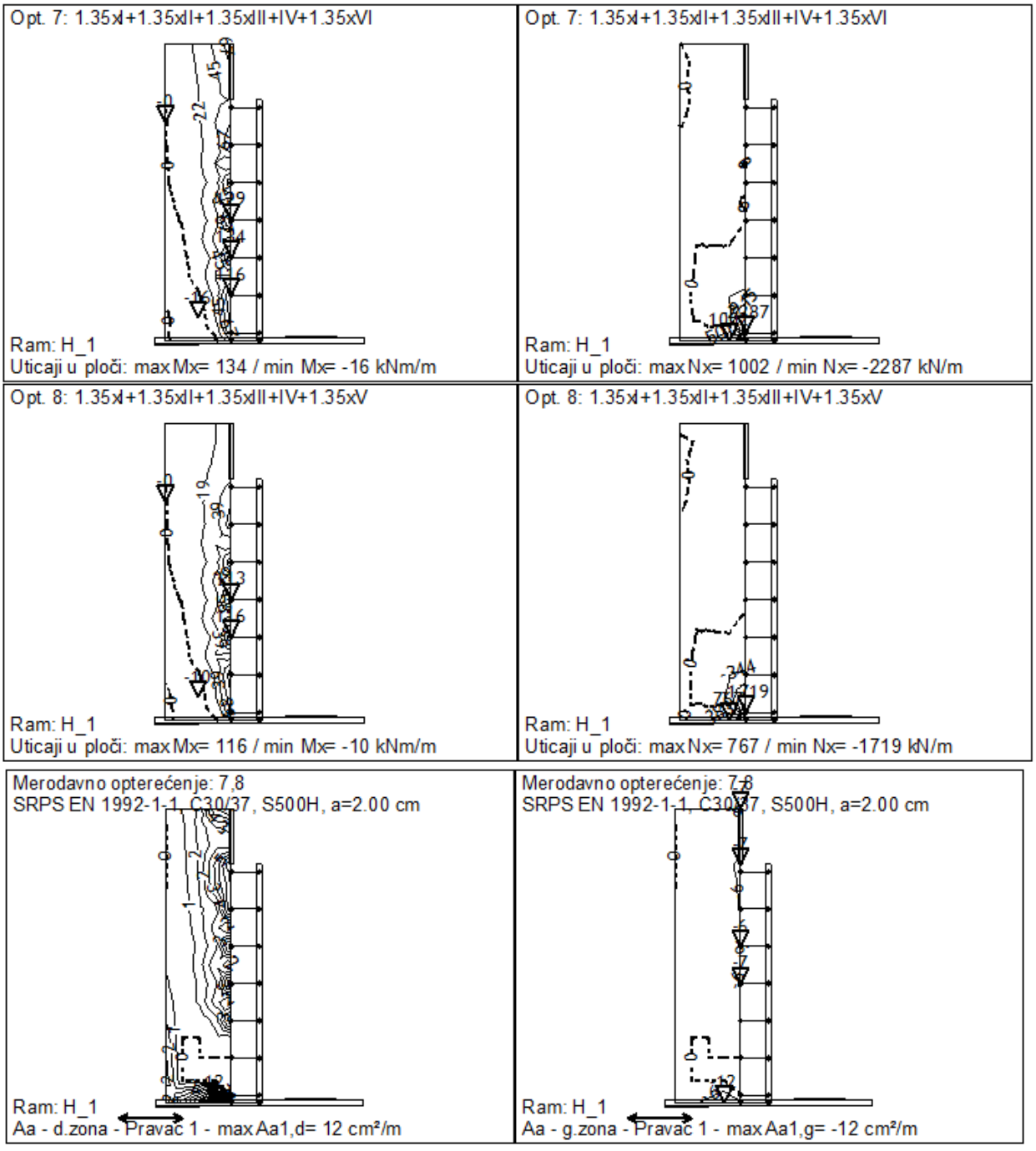
4.7.6 **Димензионисање /** Reinforcement design

Komb 1 → 1.35xI+1.35xII+1.35xIII+IV+1.35xVI

Komb 2 → 1.35xI+1.35xII+1.35xIII+IV+1.35xV

4.7.6.1 **Крило/** Wing wall l

d = 50 cm



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

Φ14/15 (Aa = 10.26 cm2/m) → **спољна страна /** outer side

Φ20/15 (Aa = 20.93 cm2/m) → **унутрашња страна** / inner side

Direction 2: (α=90°) -

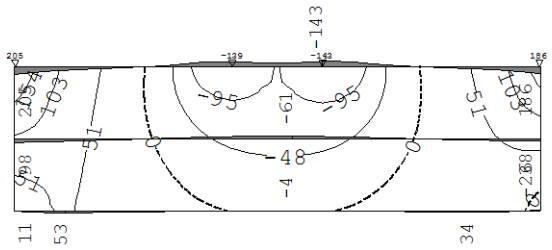
Φ14/15 (Aa = 10.26 cm2/m) → **спољна страна /** outer side

Φ20/15 (Aa = 20.93 cm2/m) → **унутрашња страна** / inner side

4.7.6.2 **Парапет/** Parapet **w**all

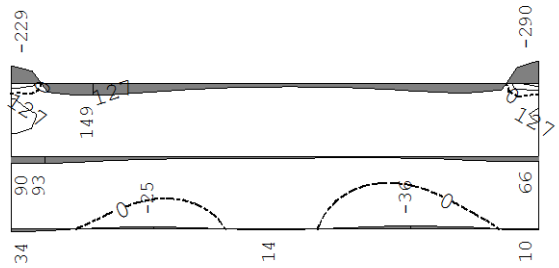
d = 30 cm

Load 7: 1.35xI+1.35xII+1.35xIII+IV+1.35xVI



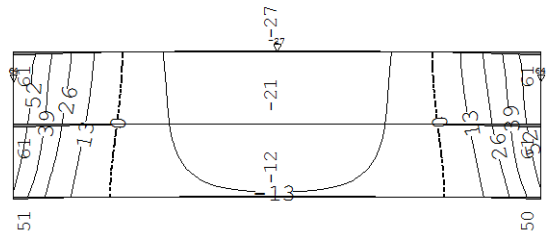
Frame: V_1
Slab Results: max Mx= 205 / min Mx= -143 kNm/m

Load 7: 1.35xI+1.35xII+1.35xIII+IV+1.35xVI



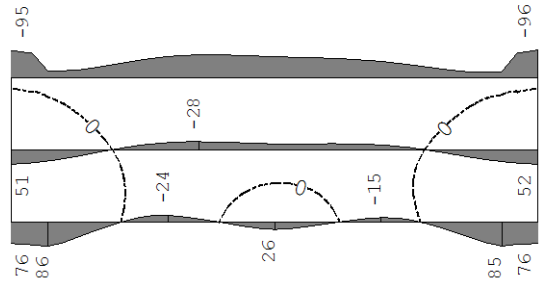
Frame: V_1
Slab Results: max Nx= 380 / min Nx= -449 kN/m

Load 8: 1.35xI+1.35xII+1.35xIII+IV+1.35xV



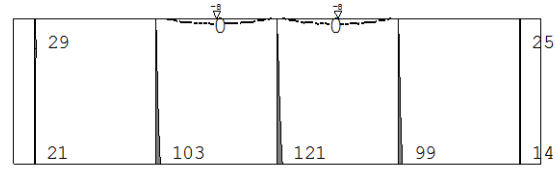
Frame: V_1
Slab Results: max Mx= 65 / min Mx= -27 kNm/m

Load 8: 1.35xI+1.35xII+1.35xIII+IV+1.35xV



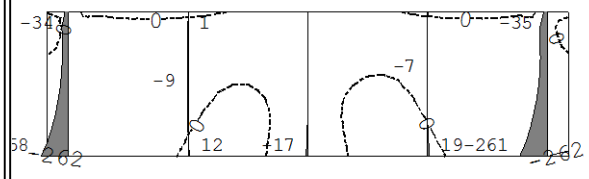
Frame: V_1
Slab Results: max Nx= 450 / min Nx= -1008 kN/m

Load 7: 1.35xI+1.35xII+1.35xIII+IV+1.35xVI



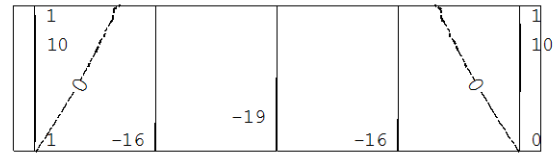
Frame: V_1
Slab Results: max My= 953 / min My= -8 kNm/m

Load 7: 1.35xI+1.35xII+1.35xIII+IV+1.35xVI



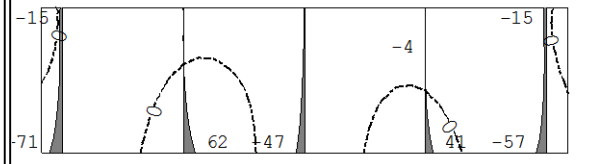
Frame: V_1
Slab Results: max Ny= 429 / min Ny= -1312 kN/m

Load 8: 1.35xI+1.35xII+1.35xIII+IV+1.35xV

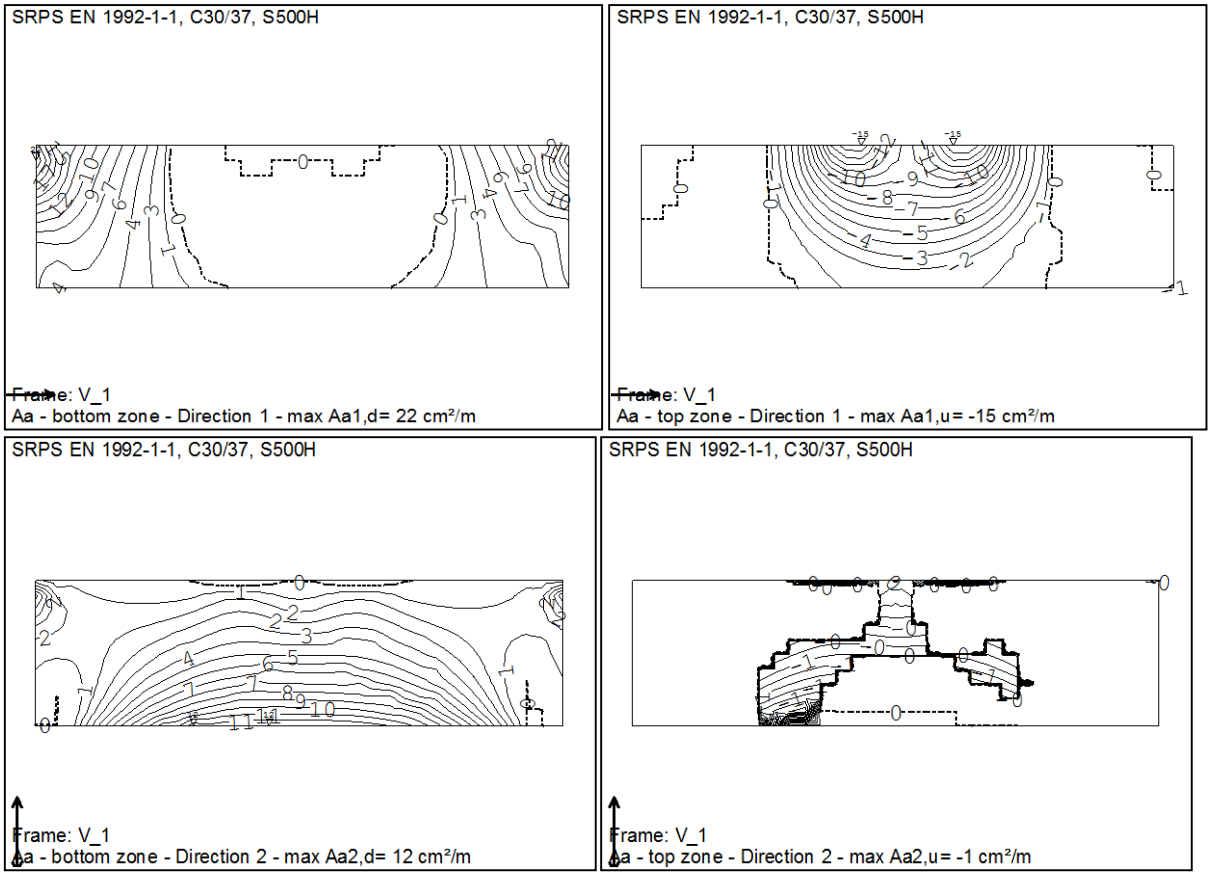


Frame: V_1
Slab Results: max My= 122 / min My= -80 kNm/m

Load 8: 1.35xI+1.35xII+1.35xIII+IV+1.35xV



Frame: V_1
Slab Results: max Ny= 1050 / min Ny= -2054 kN/m



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

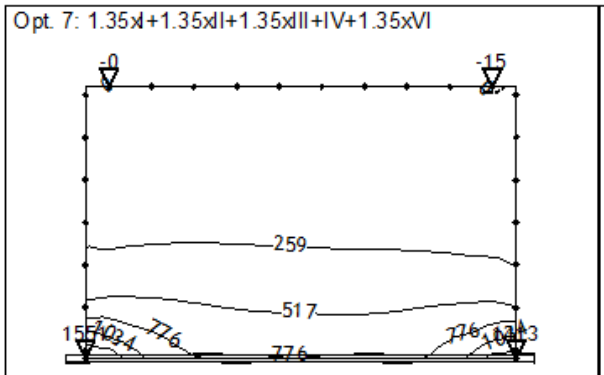
±Φ20/15 (Aa = 20.93 cm2/m)

Direction 2: (α=90°) -

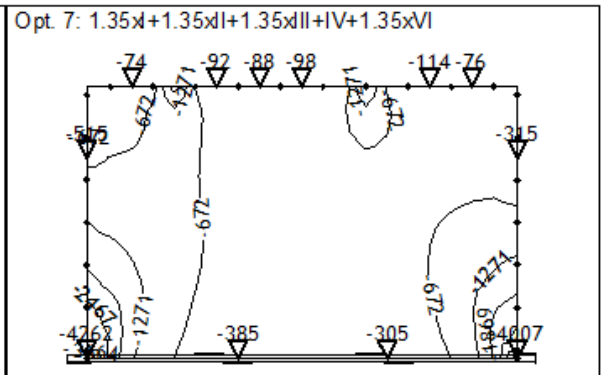
±Φ16/15 (Aa = 13.40 cm2/m)

4.7.6.3 Зид / Wall

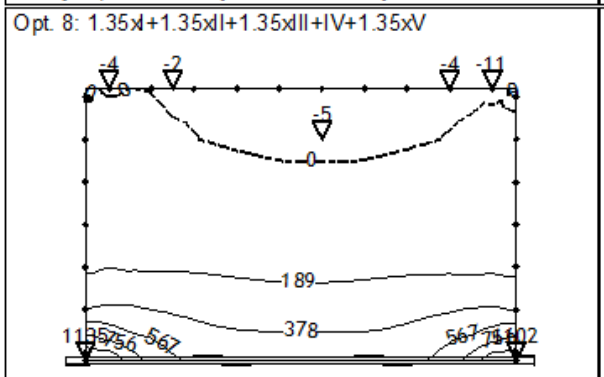
d = 100cm



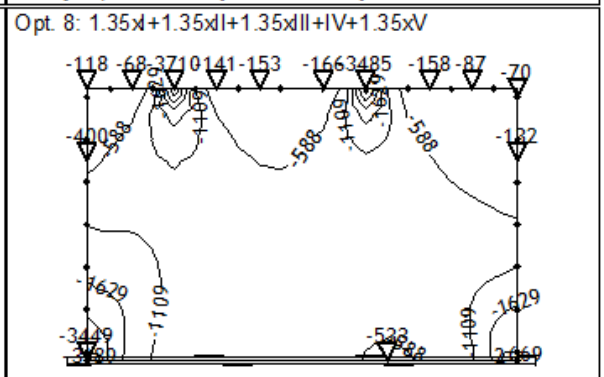
Ram: V_2
Uticaji u ploči: max My= 1551 / min My= -15 kNm/m



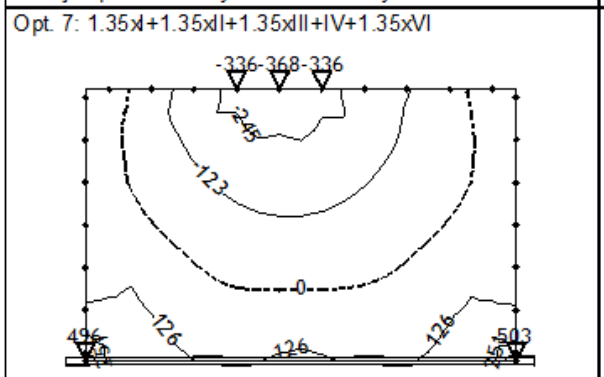
Ram: V_2
Uticaji u ploči: max Ny= -74 / min Ny= -4262 kN/m



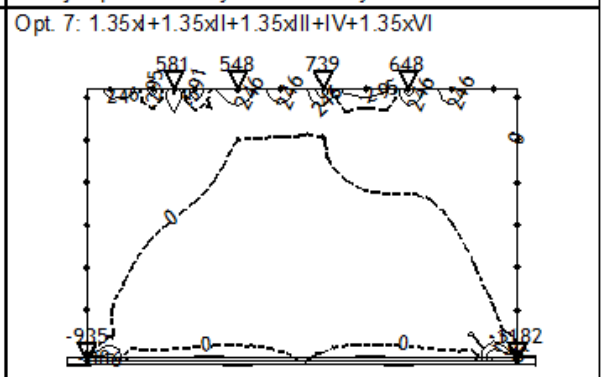
Ram: V_2
Uticaji u ploči: max My= 1135 / min My= -11 kNm/m



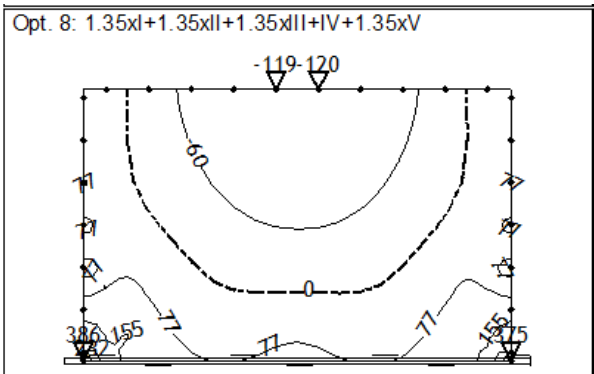
Ram: V_2
Uticaji u ploči: max Ny= -68 / min Ny= -3710 kN/m



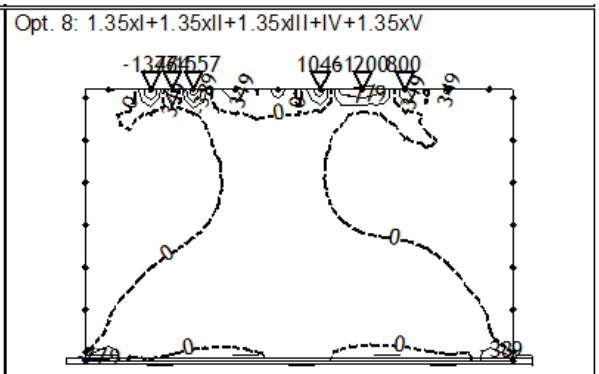
Ram: V_2
Uticaji u ploči: max Mx= 503 / min Mx= -368 kNm/m



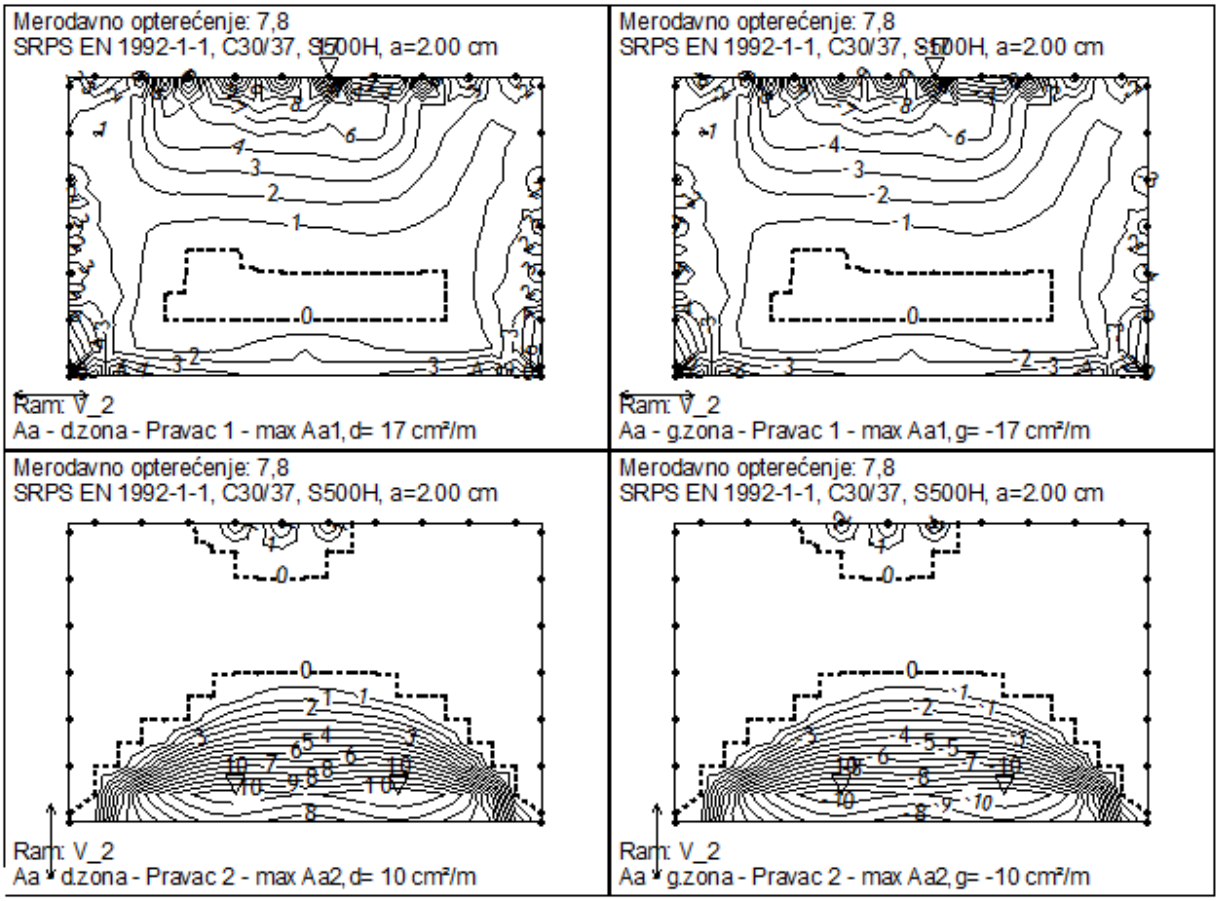
Ram: V_2
Uticaji u ploči: max Nx= 739 / min Nx= -1182 kN/m



Ram: V_2
Uticaji u ploči: max Mx= 386 / min Mx= -120 kNm/m



Ram: V_2
Uticaji u ploči: max Nx= 1046 / min Nx= -1557 kN/m



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

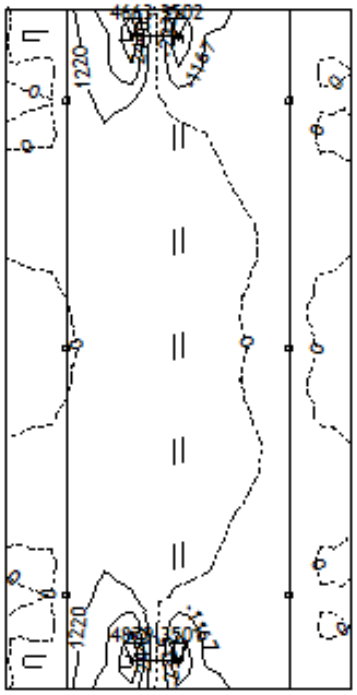
±Φ25/15 (Aa = 25.33 cm2/m)

Direction 2: (α=90°) -

±Φ20/15 (Aa = 20.93 cm2/m)

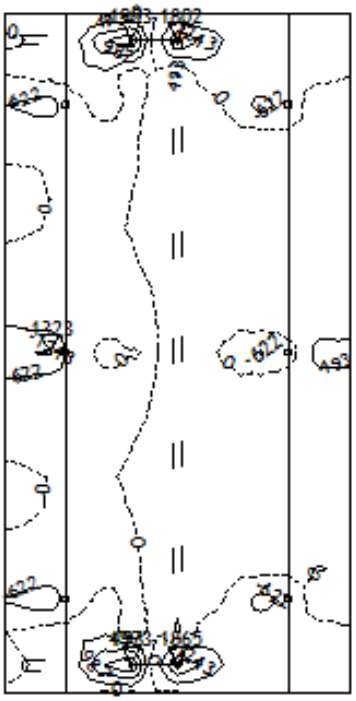
4.7.6.4 **Темељ /** Foundation

Opt. 7: 1.35xI+1.35xII+1.35xIII+IV+1.35xVI



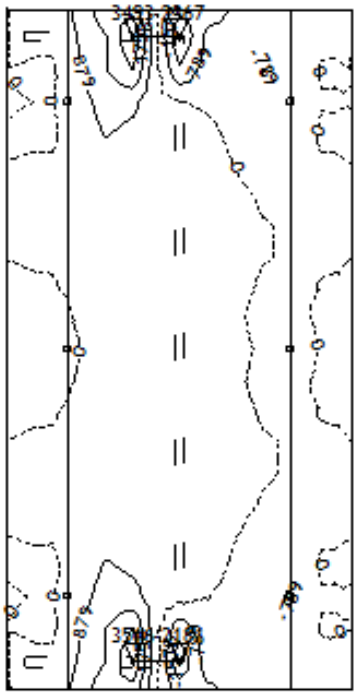
Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 4879 / min Mx= -3502 kNm/m

Opt. 7: 1.35xI+1.35xII+1.35xIII+IV+1.35xVI



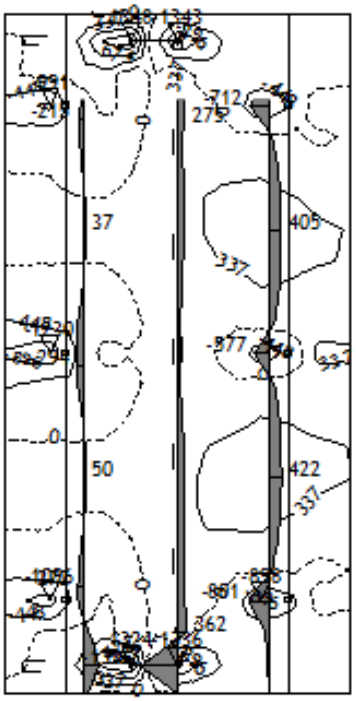
Nivo: [-7.90 m]
Uticaji u ploči: max My= 1973 / min My= -1865 kNm/m

Opt. 8: 1.35xI+1.35xII+1.35xIII+IV+1.35xV

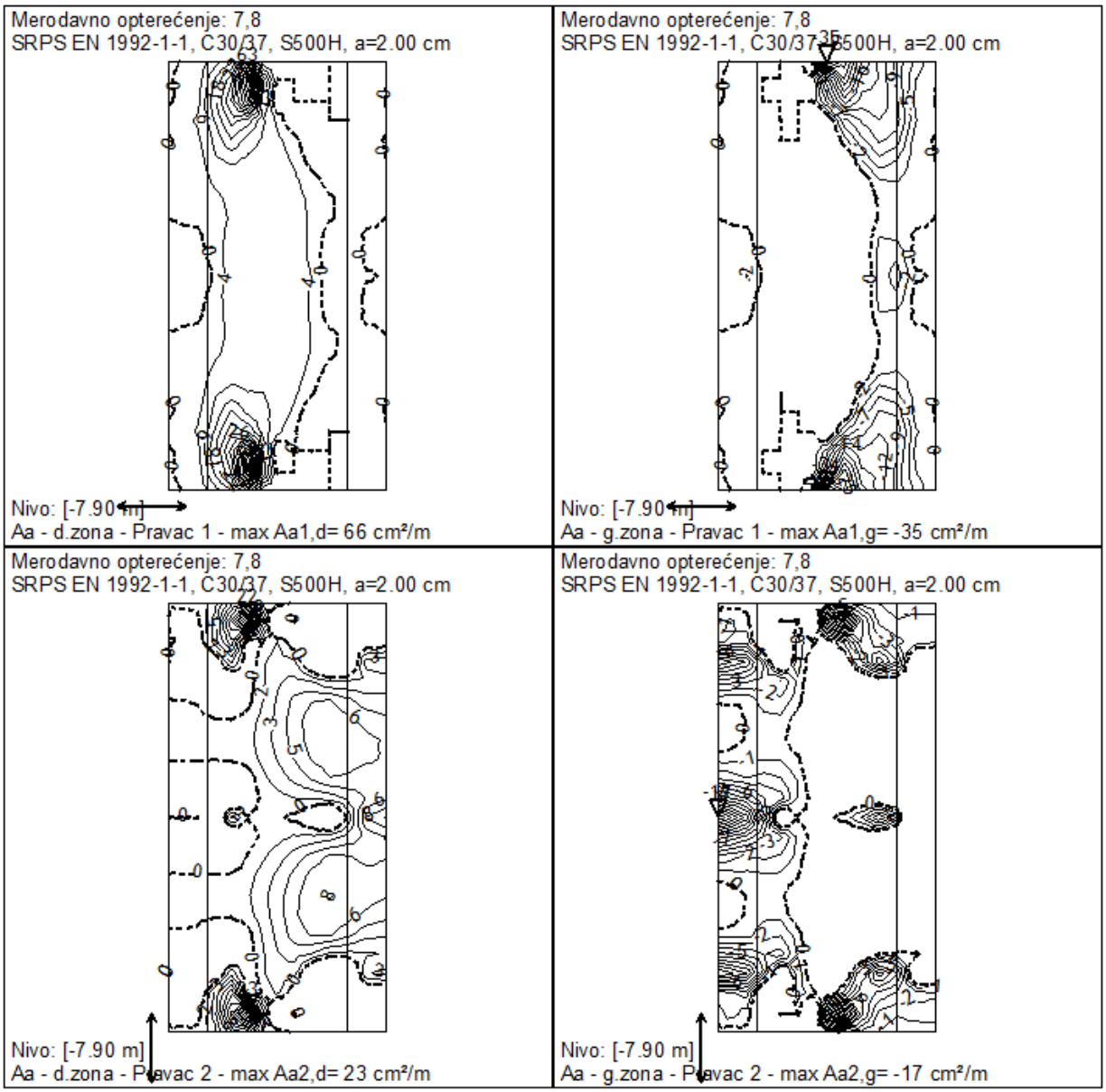


Nivo: [-7.90 m]
Uticaji u ploči: max Mx= 3516 / min Mx= -2367 kNm/m

Opt. 8: 1.35xI+1.35xII+1.35xIII+IV+1.35xV



Nivo: [-7.90 m]
Uticaji u ploči: max My= 1348 / min My= -1343 kNm/m



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

Доња зона / Bottom zone

Φ25/15 (Aa = 32.7 cm2/m)

Горња зона / Top zone

Φ25/15 (Aa = 32.7 cm2/m)

Direction 2: (α=90°) -

Доња зона / Bottom zone

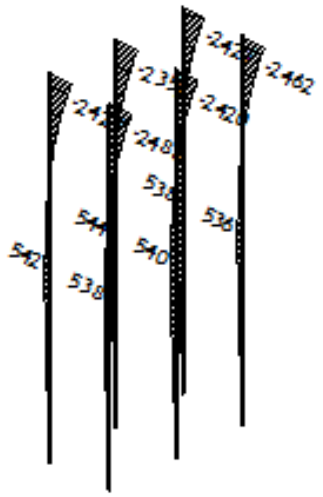
Φ25/15 (Aa = 32.7 cm2/m)

Горња зона / Top zone

Φ25/15 (Aa = 32.7 cm2/m)

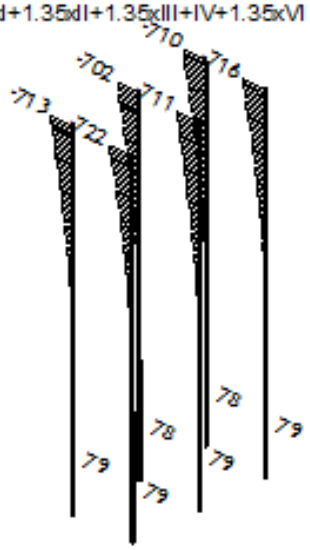
4.7.6.5 **Шипови /** Piles

Opt. 7: 1.35xd+1.35xI+1.35xIII+IV+1.35xVI



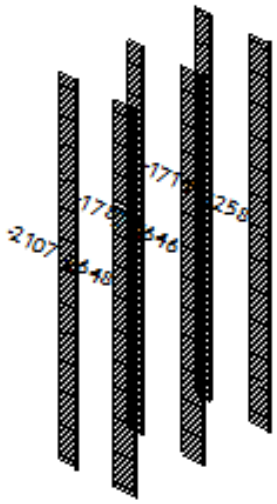
Izometrija
Uticaji u gredi: max M3= 544 / min M3= -2488 kNm

Opt. 7: 1.35xd+1.35xI+1.35xIII+IV+1.35xVI



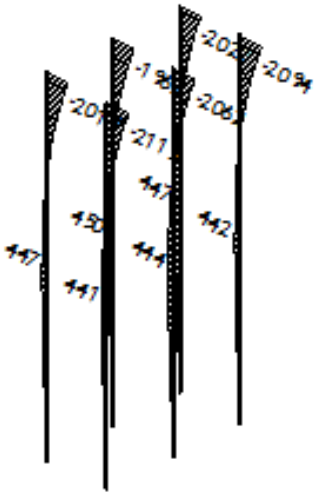
Izometrija
Uticaji u gredi: max T2= 79 / min T2= -722 kN

Opt. 7: 1.35xd+1.35xI+1.35xIII+IV+1.35xVI



Izometrija
Uticaji u gredi: max N1= -1719 / min N1= -2648 kN

Opt. 8: 1.35xd+1.35xI+1.35xIII+IV+1.35xV

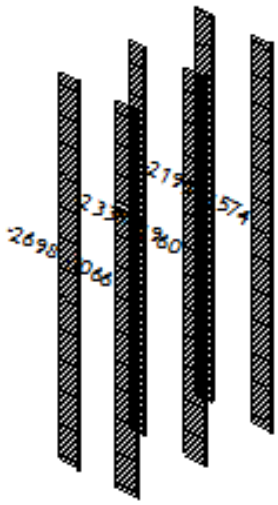


Izometrija
Uticaji u gredi: max M3= 450 / min M3= -2113 kNm

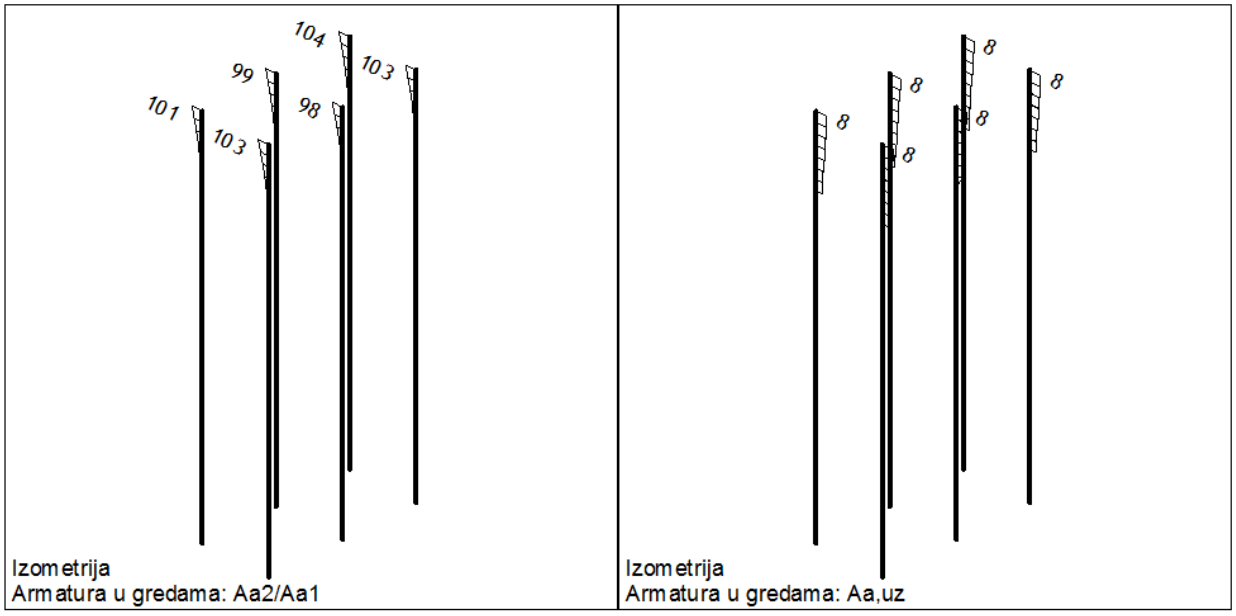
Opt. 8: 1.35xd+1.35xI+1.35xIII+IV+1.35xV

Izometrija
Uticaji u gredi: max T2= 65 / min T2= -604 kN

Opt. 8: 1.35xd+1.35xI+1.35xIII+IV+1.35xV



Izometrija
Uticaji u gredi: max N1= -2193 / min N1= -3066 kN



Минимална арматура / Minimum reinforcement

Φ120 cm → Ab = 11304 cm2

Aa,min = 0.0025xAb = 0.0025x11304 = 28.26 cm2

Усвојена арматура / Provided reinforcement

26Φ25/12.5 (Aa = 127.7 cm2) **Вертикална арматура** / Vertical reinforcement

Φ12/10 (Aa = 11.3 cm2/m) → **узенгије** / stirrups

Максимална сила у шипу / Maximal axial force

Nmax = 3066 kN ULS

Nmax = 2070 kN SLS

Београд, Април 2021.	Belgrade, April 2021
Одговорни пројектант:	Responsible designer:
Зоран Луковић, дипл.грађ.инж	Zoran Luković , grad.Civ.Eng.
лиценца бр.: 310 3032 03	Licence no.: 310 3032 03

2/1.1.17.6.2
ПРЕДМЕР И ПРЕДРАЧУН

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ
ПРУГА: СУБОТИЦА - ДРЖАВНА ГРАНИЦА (Келебија)
КЊИГА 2/1-1.17: ПРОЈЕКАТ МОСТОВА НАДВОЖЊАК
на km 102+309.98

DESIGN FOR BUILDING PERMIT
RAILWAY LINE: BELGRADE - SUBOTICA - STATE BORDER (Kelebia)
BOOK 2/1-1.17: BRIDGE DESIGN
OVERPASS at km 102+309.98

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.17.1	**02**	**ИЗВОЂЕЊЕ HW ШИПОВА**	**HW PILES**				
2/1.1.17.1.1		Извођење HW бушених шипова од бетона C 30/37, XC2,PVII У цену радова је укључен сав рад на извођењу, а плаћа се готов шип по m'. Арматура се плаћа посебно. Ø120 cm	Construct HW bored pipes of concrete C 30/37, XC2, PVII. The price covers all construction work and payment shall be made per each finished pipe, per linear meter. Reinforcement to be paid separately. Ø120cm	m'	960.00	50,000.00	48,000,000.00
2/1.1.17.1.2		Израда, уградња и монтажа арматуре HW шипова. Плаћа се по kg уграђене арматуре. B 500B	Prepare, position and tie rebars in HW piles. Payment per kg of placed rebars. B 500B	kg	115,200.00	120.00	13,824,000.00
2/1.1.17.1.3		Пробно оптерећење шипова, испитивање носивости шипова.	Carry out trial loading of piles to test pile capacity Lump sum payment.	паушално / lump sum			1,854,720.00

УКУПНО ИЗВОЂЕЊЕ HW ШИПОВА:	**TOTAL FOR HW PILES:**	**63,678,720.00**

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ
ПРУГА: СУБОТИЦА - ДРЖАВНА ГРАНИЦА (Келебија)
КЊИГА 2/1-1.17: ПРОЈЕКАТ МОСТОВА
НАДВОЖЊАК на km 102+390.98

DESIGN FOR BUILDING PERMIT
RAILWAY LINE: BELGRADE - SUBOTICA - STATE BORDER (Kelebia)
BOOK 2/1-1.17: BRIDGE DESIGN
OVERPASS at km 102+390.98

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.17.2	**03**	**ЗЕМЉАНИ РАДОВИ**	**EARTHWORKS**				
2/1.1.17.2.1		Ископ темеља у материјалу I и II категорије, са свом потебном подградом и транспортом ископаног материјала до 5 km. Плаћа се по m^3 ископаног материјала - на дубини 0-2 m - на дубини 2-4 m	Excavate foundations in soil cat. I & II, place necessary timbering and haul excavated earth to 5 km distance. Payment per m^3 of excavated material - 0-2 m by depth - 2-4 m by depth	 m^3 m^3	 1,718.08 0.00	 890.00 1,200.00	 1,529,091.20 0.00
2/1.1.17.2.2		Насипање материјала / затрпавање темеља стубова, из ископа или позајмишта, у слојевима по 30 cm, земљаним материјалом, са набијањем слојева до модула стшљивости Ms=30MPa. Плаћа се по m^3 набијеног материјала	Backfill pier foundations using earth from borrow pit, in 30 cm layers tamped to modulus of compresibility of Ms=30MPa. Payment per m^3 of tamped earth	m^3	1,142.46	1,800.00	2,056,435.20
2/1.1.17.2.3		Израда шљунчаног клина иза крајњих стубова, до нивоа доње ивице прелазне плоче, од добро гранулисаног шљунка збијеног у слојевима од 30cm до модула стишљивости Ms=40 MPa.	Build gravel wedges behind end piers up to the transition slab underside of well grained gravel tamped in 30 cm layers to modulus of compressibility of Ms=40MPa.	m^3	708.00	2,000.00	1,416,000.00
2/1.1.17.2.4		Израда кегли, према пројекту, материјалом добијеним из усека или позајмишта са механичким набијањем у слојевима од по 30cm.	Build newly designed backwalls of earth recovered from cuttings or borrow pits and tamp them mechanically, 30 cm layers.	m^3	84.00	2,900.00	243,600.00
		УКУПНО ЗЕМЉАНИ РАДОВИ:	**TOTAL EARTH WORKS:**				**5,245,126.40**
2/1.1.17.3	**04**	**БЕТОНСКИ И АРМИРАНОБЕТОНСКИ РАДОВИ**	**PLAIN AND REINFORCED CONCRETE**				

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КЊИГА 2/1-1.17: ПРОЈЕКАТ МОСТОВА
НАДВОЖЊАК на km 102+390.98

DESIGN FOR BUILDING PERMIT
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		Све позиције обухватају поред описа појединачних ставки и следеће заједничке услове : - Бетонски радови ће бити изведени у свему по пројекту, статичком прорачуну и важећим правилницима. Цене садрже све радне операције, утрошке материјала, помоћни алат, оплате и скеле које прописују "Нормативи и стандарди рада у грађевинарству-Високоградња ГН 400", као и остале трошкове и зараду предузећа. - Бетон ће бити справљен, транспортован, уграђен, негован и испитиван на пробним узорцима по одредбама SRPS EN 206 за бетон. - Бетон ће бити справљен од агрегата и цемента атестираних по важећим српским стандардима. - Бетон класе B.II мора имати све класе отпорности дефинисане појединачним позицијама. - Обрачун количина стварно изведених радова извршиће се према одредбама које прописују "Нормативи и стандарди рада у грађевинарству". -Мешање бетона мора се вршити машинским путем, а набијање вибрирањем -Арматура се плаћа посебно -Каблови се плаћају посебно -У цену бетона је урачуната оплата и скела -Плаћа се за потпуно готов посао од m^3 уграђеног бетона				
	04.01	**Неармирани бетон**	**Plain concrete**				
2/1.1.17.3.1		Мршави бетон - изравњавајући слој, дебљине 10 cm, C12/15, испод темеља стубова, крилних зидова, темељних плоча, наглавних греда, прелазних плоча од бетона.	Cast lean concrete C12/15 for 10 cm thick blinding layers under pier foundations, wing walls, foundation slabs, pile caps, transition slabs.	m^3	42.85	12,000.00	514,224.00
	04.02	**Армирано бетонске темељне конструкције**	**Reinforced concrete foundations**				
2/1.1.17.3.2		Армирани бетон темеља стубова и темеља крилних зидова, тракастих темеља, контра-греда, плочастих темеља, јастука, наглавних греда и бунара. Бетон класе : C 30/37, XC2,PVII	Cast reinforced concrete in pier and wingwall foundations, strip foundations, counter beams, foundation mats, cushions, pile caps and wells. Concrete class: C 30/37, XC2,PVII	m^3	575.62	21,600.00	12,433,305.60
	04.03	**Стубови као ослонци распонских конструкција разних система и лежишне греде**	**Supporting piers under spanning construction of various systems and bearing beams**				
2/1.1.17.3.3		Тело крајњих стубова од бетона класе C 30/37, XC4, XD1, XF2, PV-I	Cast bodies of end piers concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	138.99	27,600.00	3,835,986.00
2/1.1.17.3.4		Крила и крилни зидови крајњих стубова од бетона класе C 30/37, XC4, XD1, XF2, PV-I	Cast wings and wing walls on end piers of concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	47.70	27,600.00	1,316,520.00

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НАДВОЖЊАК на km 102+390.98

DESIGN FOR BUILDING PERMIT
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2/1.1.17.3.5		Лежишне греде крајњих стубова од бетона класе С 30/37, XC4, XD1, XF2, PV-I	Cast bearing beams on end piers of concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	0.00	27,600.00	0.00
2/1.1.17.3.6		Парапети, маске крајњих стубова од бетона класе С 30/37, XC4, XD1, XF2, PV-I	Cast parapet walls and masks on end piers of concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	17.35	27,600.00	478,777.20
2/1.1.17.3.7		Пешачке конзоле на крилима крајњих стубова од бетона класе С 30/37, XC4, XD1, XF2, PV-I	Cast footway cantilevers on end pier wings of concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	4.00	30,600.00	122,400.00
2/1.1.17.3.8		Тело средњих стубова од бетона класе С 30/37, XC4, XD1, XF2, PV-I	Cast bodies of middle piers of concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	232.42	27,600.00	6,414,792.00
2/1.1.17.3.9		Лежишне греде и маске средњих стубова од бетона класе С 30/37, XC4, XD1, XF2, PV-I	Cast bearing beams and masks on middle piers of concrete class C 30/37, XC4, XD1, XF2, PV-I	m^3	25.20	30,600.00	771,120.00
2/1.1.17.3.10		Квадери крајњих и средњих стубова од бетона класе С 40/50, XC4, XF1,PVI	Cast squared stones on end and middle piers of concrete class C 40/50, XC4, XD1, XF2, PV-I	m^3	1.00	30,600.00	30,551.04
	04.04	**Распонска конструкција моста од армираног бетона**	**Bridge constructions in spans of reinforced concrete**				
2/1.1.17.3.11		Коловозна плоча од армираног бетона преко монтажних носача. У цену урачуната привремена оплата између монтажних носача. Бетон класе С 35/45, XC4, XD1, XF2, PV-II	Cast bridge deck of reiforced concrete on top of precast girders. Price includes temporary formwork between precast girders. Concrete class C 35/45, XC4, XD1, XF2, PV-II.	m^3	0.00	30,600.00	0.00
2/1.1.17.3.12		Армиранобетонски попречни носачи за везу главних носача. Бетон класе С 35/45, XC4, XD1, XF2, PV-II	Cast reinforced concrete cross girders connecting main girders. Concrete class C 35/45, XC4, XD1, XF2, PV-II	m^3	0.00	27,000.00	0.00
2/1.1.17.3.13		Ивични венци пешачких стаза ливени на лицу места, (укључујући и ревизионе шахтове) од бетона класе С 40/50, XC4, XD3, XF4, PV-II	Cast in situ footway cornices (with inspection chambers) of concrete class C 40/50, XC4, XD3, XF4, PV-II	m^3	292.66	37,200.00	10,886,803.20
2/1.1.17.3.14		Прелазне плоче, од бетона С 30/37, XC4	Cast transition slabs of concrete C 30/37, XC4	m^3	26.00	25,200.00	655,200.00
	04.05	**Распонска конструкција моста од преднапрегнутог бетона**	**Bridge construction in span of prestressed concrete**				
2/1.1.17.3.15		Главни носачи од преднапрегнутог бетона Бетон:С 45/55,XC4, XD1, XF2, PV-II цемент класе "N"	Main girders made from pre-stressed concrete Concrete: C 45/55,XC4, XD1, XF2, PV-II cement class "N"	m^3	1,911.25	42,000.00	80,272,584.00

УКУПНО БЕТОНСКИ РАДОВИ: TOTAL FOR CONCRETING:	**117,732,263.04**

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2/1.1.17.4	**05**	**РАДОВИ ОД МЕТАЛА**	**METALWORK**				
		Све позиције обухватају поред описа појединачних ставки и следеће заједничке услове: - Армирачки радови ће бити изведени у свему по пројекту, статичком прорачуну и важећим правилницима. Цене садрже све радне операције, утрошке материјала, помоћни алат и скеле које прописују "Нормативи и стандарди рада у грађевинарству-Високоградња ГН 400", као и остале трошкове и зараду предузећа. - Арматуру очистити од рђе и прљавштине, исправити, исећи, савити и уградити по детаљима (арамтурним нацртима) и статичком прорачуну. - За квалитет уграђене арматуре одговара извођач радова. - Јединична цена садржи и постављање подметача од челика,пластике или бетона за постизање предвиђених заштитних слојева и правилног положаја арматуре у конструкцији. Сва подеона гвожђа и узенгије ће бити чврсто везани за главну арматуру тако да не може доћи до промене положаја арматуре за време бетонирања конструкције. - Стварно уграђена количина арматуре свих квалитета обрачунава се по kg без обзира на сложеност и пречнике шипки арматуре. - Обрачун количина извршити према табличним тежинама арматуре и ужади и дужинама из арматурних нацрта.				
2/1.1.17.4.1		Набавка, чишћење, сечење, машинско савијање и монтажа арматуре према пропису, пројекту и статичким детаљима. Плаћа се по kg уграђене арматуре. Ребраста арматура B 500B	Purchase, wire brush, cut, bend mechanically and position bars according to the regulation, the design and the static detailed drawings. Payment per kg of positioned bars. Ribbed reinforcement B 500B	kg	490,826.16	120.00	58,899,139.20
2/1.1.17.4.2		Високовредна, патентирана ужад за преднапрезање са свим котвама, подложним плочицама, пресама и заштитним цевима за каблове. Класа Y1860S19-16.0-A. Плаћа се по kg уграђеног челика за преднапрезање.	Patented high-strength prestressing strands with all anchors, bearing plates, jacks and protective cable pipes . Class Y1860S19-16.0-A. Payment per kg of positioned bars.	kg	57,798.76	400.00	23,119,504.00

УКУПНО АРМИРАЧКИ РАДОВИ:	**TOTAL METALWORK:**	**82,018,643.20**

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2/1.1.17.5	**06**	**ИЗОЛАТЕРСКИ РАДОВИ**	**WATERPROOFING**				
		- Сви изолатерски радови морају бити изведени педантно и тачно према захтевима из пројекта, предрачуна радова и детаљима. - Употребљени материјали морају одговарати важећим стандардима и прописима, снабдевени атестима овлашћене установе, проверени у употреби, трајни колико и објекат или пројектовани тако да је њихова замена могућа. - Све грешке на конструкцији морају се на одговарајући начин отклонити или санирати пре почетка наношења изолационог материјала. - У јединичну цену је урачуната набавка свог потребног материјала, алата, транспорт и израда. - Плаћа се за потпуно готов посао по m^2 урађене изолације и/или заштите.					
2/1.1.17.5.1		Израда хидроизолације горње плоче и конзола на бази метил метакрилата, прскањем под притиском. Радови по овој позицији се изводе у складу са техничким условима и нормативима за ову врсту послова као и по технологији произвођача. У цену су у рачунати набавка материјала, транспорт и уградња.	Spray under pressurea layer of waterproofing material based on methyl metacrilate on deck and cantilevers.Work against this item shall conform to the relevant technical conditions and standards, and the manufacturer's technology. The price includes purchase of materials, transport and application.	m^2	2,677.29	4,150.00	11,110,753.50
2/1.1.17.5.2		Израда хидроизолације од једног хладног премаза битулитом и једног премаза врућим битуменом бетонских површина које су у контакту са земљом.	Apply waterproofing of one cold coat of bitumen emulsion and one hot bitumen coat onto concrete surfaces in contact with ground.	m^2	1,218.47	1,200.00	1,462,164.00
2/1.1.17.5.3		Израда заштите бетонских површина заштитним хидрофобним премазом за бетон, на бази пенетрата. Површине морају бити претходно очишћене и суве. Премазивање подразумева заштиту и импрегнацију свих видљивих бетонских површина моста које су у додиру са атмосферским утицајима.	Protect concrete surfaces with protective hydrophobic penetrat-based coats. Surfaces shall be clean and dry prior to application. This means that all visible concrete surfaces on the bridge exposed to atmosphere shall be coated for the purpose of protection and impregnation.	m^2	4,488.55	2,000.00	8,977,100.00
2/1.1.17.5.4		Заштитни премаз бетона на пешачким стазама, степеницама и подестима, d=3-3.5 mm, формираног од 4 слоја:епокси прајмер, водоотпорни слој пур смоле, основни премаз пур смоле(полиуретан) са кварц песком (0.5-1 mm) и завршни слој пур смоле.	Apply protective coats onto concrete surface on footways, steps and landings, 3-3.5 mm thick, 4-ply of epoxy primer, water repellent pur resin, base coat of pur resin (polyurethane) with quartz sand (0.5-1 mm) and top coat of pur resin.	m^2	1,243.70	2,500.00	3,109,237.50
УКУПНО ИЗОЛАТЕРСКИ РАДОВИ:			**TOTAL WATERPROOFING:**				**24,659,255.00**

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2/1.1.17.6	**07**	**ЛЕЖИШТА И ДИЛАТАЦИЈЕ**	**BEARINGS AND EXPANSION JOINTS**				
2/1.1.17.6.1		Израда и постављање лончастих лежишта. Плаћа се по комаду постављеног лежишта. попречно непокретна Nd=3600 kN; Vx,d=330 kN, Ud=±85mm	Cast and position pot bearings. Payment per each bearing in place. fixed in transverse direction, Nd=3600 kN; Vx,d=330 kN, Ud=±85mm	ком	8.00	250,000.00	2,000,000.00
2/1.1.17.6.2		Армиране еластомерне дилатационе спојнице , набавка и уградња према пројекту Плаћа се по m' уграђене дилатационе спојнице.	Reinforced elastomer expansion joints, purchase and fixing as designed. Payment per each fixed expansion joint.				
		средња померања Ud=±85mm	for medium movement Ud=±85mm	m'	22.30	100,000.00	2,230,000.00
		средња померања Ud=±170mm	for medium movement Ud=±170mm	m'	11.15	100,000.00	1,115,000.00
УКУПНО ЛЕЖИШТА И ДИЛАТАЦИЈЕ: TOTAL BEARINGS AND EXPANSION JOINTS:							**5,345,000.00**
2/1.1.17.7	**08**	**ОСТАЛИ РАДОВИ**	**MISCELLANEOUS**				
		За све позиције наведених радова важи: * у цену је урачуната набавка свог потребног материјала, алата, механизације, транспорт, израда и монтажа према пројекту, а за комплетно завршен					
2/1.1.17.7.1		Сливници од ливеног гвожђа C-6, набавка и уградња према пројекту. Плаћа се по комаду уграђеног сливника.(део Пројекта одводњавања)	Purchase and fix cast iron gullies C-6 according to design. Payment per each gully in place (treated in Drainage design).	ком	10.00	50,000.00	500,000.00
2/1.1.17.7.2		Ливене цеви за одвод воде из сливника укључујући и сав причврсни прибор. Плаћа се по m' уграђене цеви. (део Пројекта одводњавања)	Place cast iron gully piping and all fittings. Payment per m' of gully piping (treated in Drainage design).	m'	200.00	2,700.00	540,000.00
2/1.1.17.7.3		Израда и постављање ограде од челика S 235 JRG1. У цену је урачуната набавка материјала, израда, транспорт, монтажа, антикорозиона заштита са два основна и два завршна премаза покривном бојом, а у свему према пројекту. Плаћа се по kg постављене ограде.	Assemble and erect railing and fence of S 235 JRG1 steel. The price includes purchase of material, assembly transport, erection, anticorrosive protection of two primers and two top coats of paint, fully as designed. Payment per kg of railing/fence.				
		-цевне или од профила	- tubular railing or sections	kg	21,369.00	250.00	5,342,250.00
		- висока жичана заштитна ограда	- high protective fence of steel mesh	kg	1,768.00	250.00	442,000.00
2/1.1.17.7.4		Коловозни застор од асфалт бетона, дебљине	Spread surfacing of asphalt concrete, 7 cm thick.	m^2	1,665.30	1,600.00	2,664,480.00
2/1.1.17.7.5		Уграђивање ПВЦ цеви у пешачке (ревизионе) стазе Ф100mm. Плаћа се по m' уграђених цеви.	Insert PVC pipes in footways (inspection ways) Ф100mm. Payment per m' of inserted pipes.	m'	1,573.80	450.00	708,210.00

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ
ПРУГА: СУБОТИЦА - ДРЖАВНА ГРАНИЦА (Келебија)
КЊИГА 2/1-1.17: ПРОЈЕКАТ МОСТОВА
НАДВОЖЊАК на km 102+390.98

DESIGN FOR BUILDING PERMIT
RAILWAY LINE: BELGRADE - SUBOTICA - STATE BORDER (Kelebia)
BOOK 2/1-1.17: BRIDGE DESIGN
OVERPASS at km 102+390.98

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.17.7.6		Израда и затварање спојница на контакту на асфалта и ивичњака и уз дилатационе справе трајно еластичном масом. Плаћа се по m' уграђене спојнице.	Prepare and close joints in concrete surface at the joints between asphalt and curb lines and at expansion joints with durably elastic mass. Payment per m' of finished joint.	m'	563.60	3,000.00	1,690,800.00
2/1.1.17.7.11		Израда и затварање спојница на бетону на степенишном делу, уз ивичњаке и венце на пешачким стазама, трајно еластичном масом. Плаћа се по m' уграђене спојнице.	Prepare and close joints in concrete surface on the stairs, between curb lines and footway cornices a with durably elastic mass. Payment per m' of finished joint.	m'	591.80	3,000.00	1,775,400.00
2/1.1.17.7.7		Ивичњаци бетонски или камени 20/25 cm.	Place curbs of concrete or stone 20/25 cm	m'	524.60	2,600.00	1,363,960.00
2/1.1.17.7.8		Испитивање готовог моста.	Test the newly built bridge.	паушално / lump sum			1,500,000.00
2/1.1.17.7.9		Фотографско снимање у току изградње моста.	Make photo records in the course bridge building	паушално / lump sum			150,000.00
2/1.1.17.7.10		Израда и уграђивање плоче са годином изградње моста.	Prepare and fix a plate inscribed with the year of bridge building.	паушално / lump sum			15,000.00

УКУПНО ОСТАЛИ РАДОВИ:	**TOTAL MISCELLANEOUS:**	**16,692,100.00**

ЗБИРНА РЕКАПИТУЛАЦИЈА GRAND SUMMARY

2/1.1.17.1	**02**	**ИЗВОЂЕЊЕ HW ШИПОВА**	**HW PILES**	**63,678,720.00**
2/1.1.17.2	**03**	**ЗЕМЉАНИ РАДОВИ**	**EARTHWORKS**	**5,245,126.40**
2/1.1.17.3	**04**	**БЕТОНСКИ И АРМИРАНОБЕТОНСКИ РАДОВИ**	**PLAIN AND REINFORCED CONCRETE**	**117,732,263.04**
2/1.1.17.4	**05**	**РАДОВИ ОД МЕТАЛА**	**METALWORK**	**82,018,643.20**
2/1.1.17.5	**06**	**ИЗОЛАТЕРСКИ РАДОВИ**	**WATERPROOFING**	**24,659,255.00**
2/1.1.17.6	**07**	**ЛЕЖИШТА И ДИЛАТАЦИЈЕ**	**BEARINGS AND EXPANSION JOINTS**	**5,345,000.00**
2/1.1.17.7	**08**	**ОСТАЛИ РАДОВИ**	**MISCELLANEOUS**	**16,692,100.00**

УКУПНО (дин): **GRAND TOTAL (Din):** **315,371,107.64**

Београд, Април 2021. Belgrade, April 2021

Одговорни пројектант: Responsible designer:

Зоран Луковић, дипл.грађ.инж
лиценца бр.: 310 3032 03

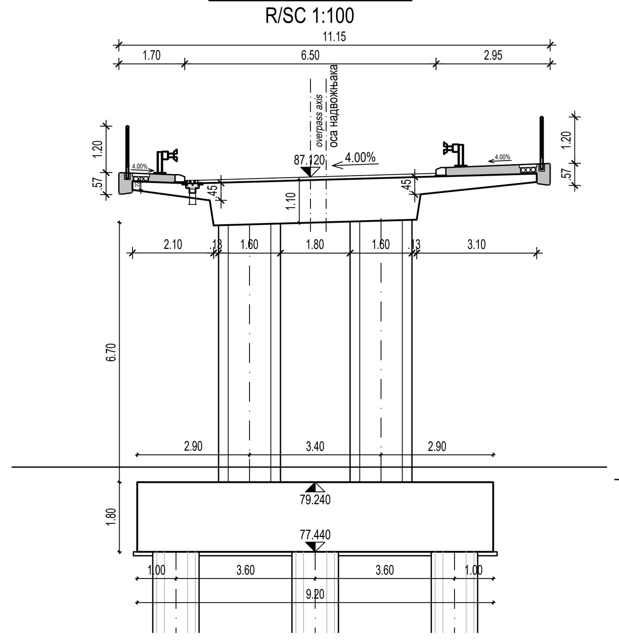
Zoran Luković , grad.Civ.Eng.
Licence no.: 310 3032 03

2/1.1.17.7
ГРАФИЧКА ДОКУМЕНТАЦИЈА

ОСНОВА
PLAN VIEW
R/SC 1:200

ПОДУЖНИ ПРЕСЕК
LONGITUDINAL SECTION
R/SC 1:200

ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C2
CROSS SECTIONS AT PIER S2
R/SC 1:100



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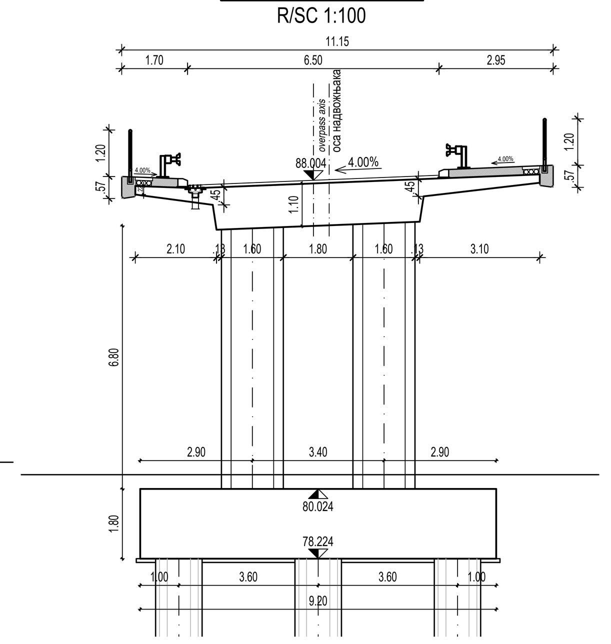
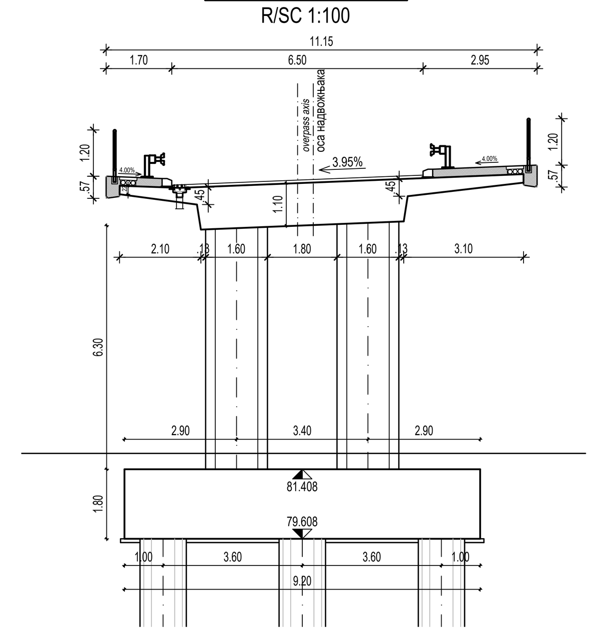
CROSS SECTIONS AT PIER S3
R/SC 1:100



ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C4
CROSS SECTIONS AT PIER S4
R/SC 1:100



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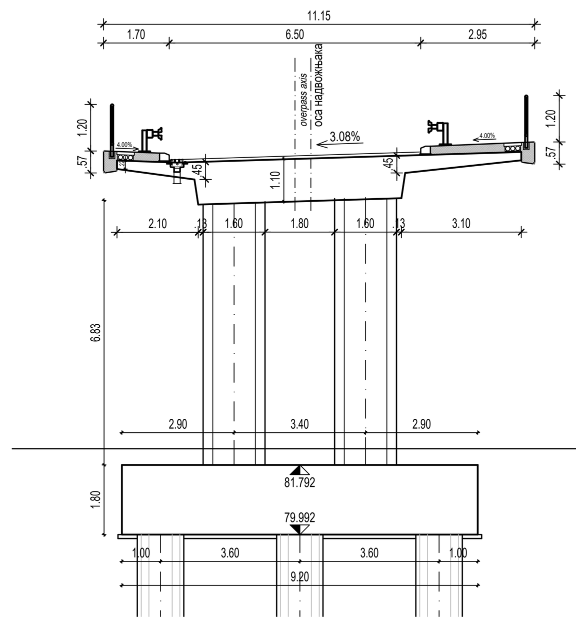
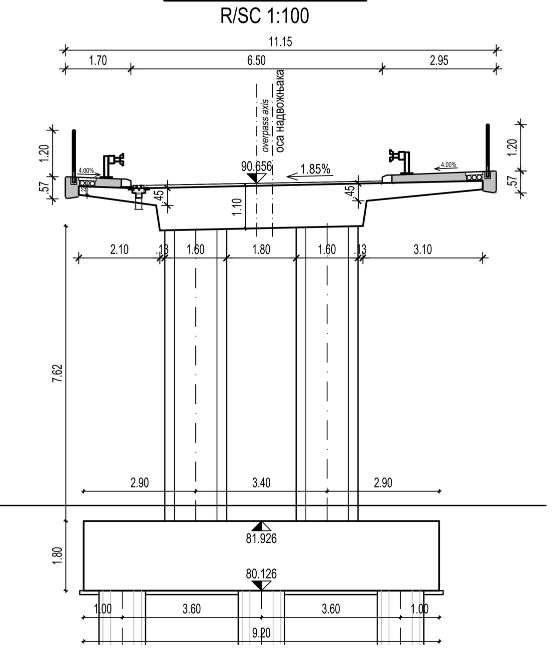
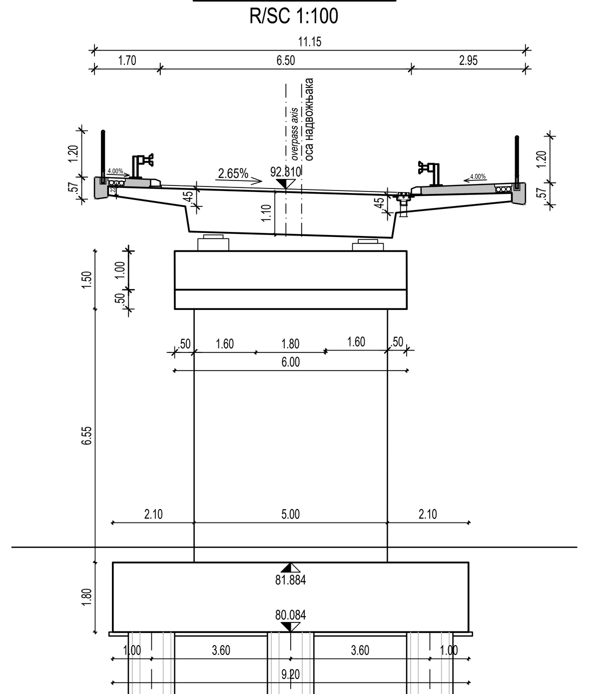
CROSS SECTIONS AT PIER S5
R/SC 1:100



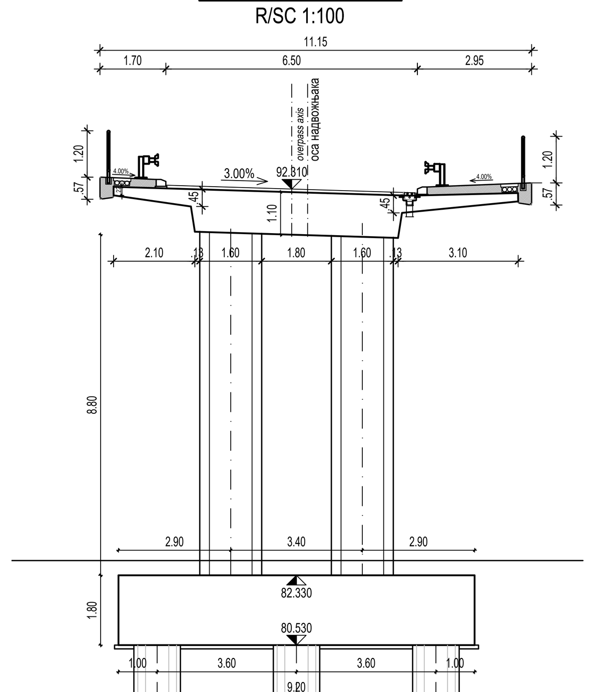
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C6
CROSS SECTIONS AT PIER S6
R/SC 1:100



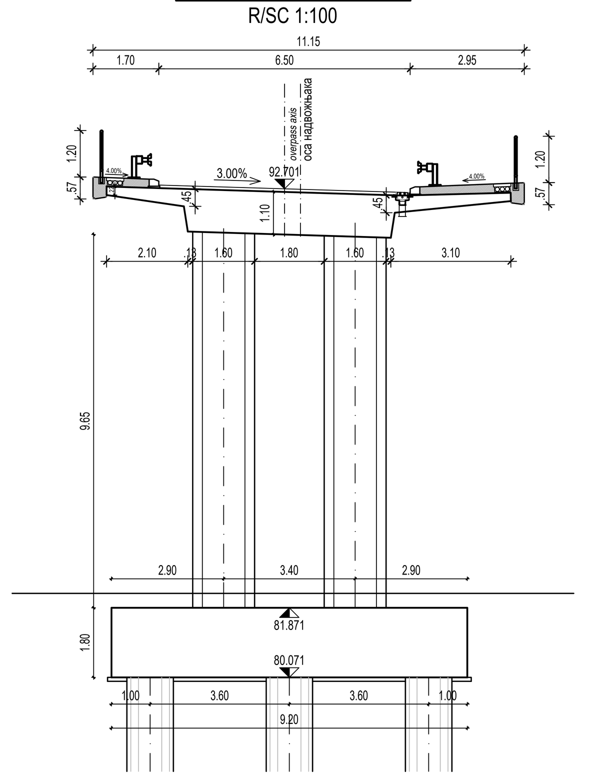
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C7
CROSS SECTIONS AT PIER S7
R/SC 1:100



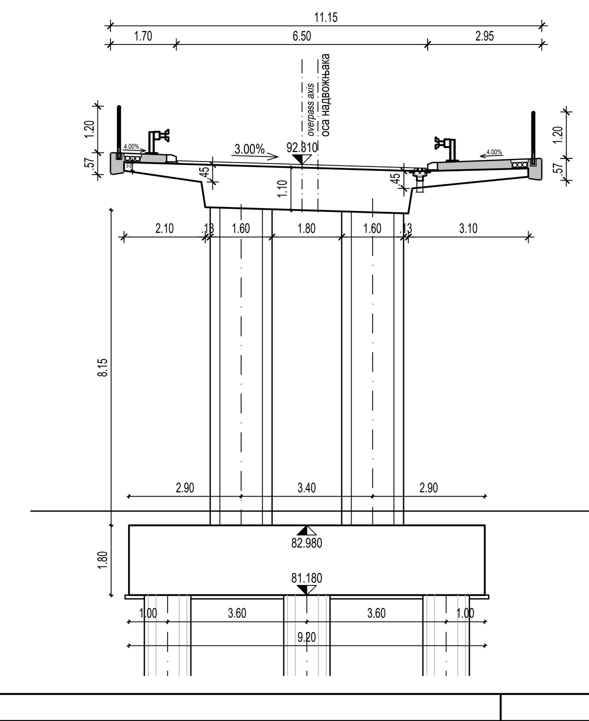
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C8
CROSS SECTIONS AT PIER S8
R/SC 1:100



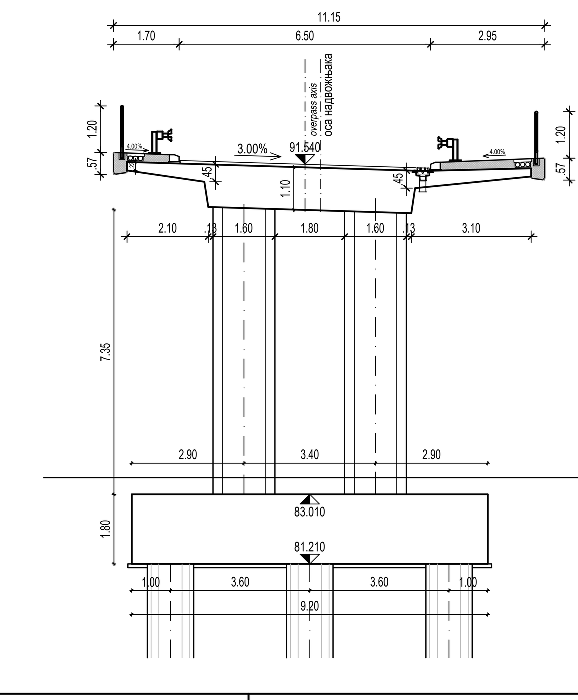
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C9, C10
CROSS SECTIONS AT PIER S9, S10
R/SC 1:100



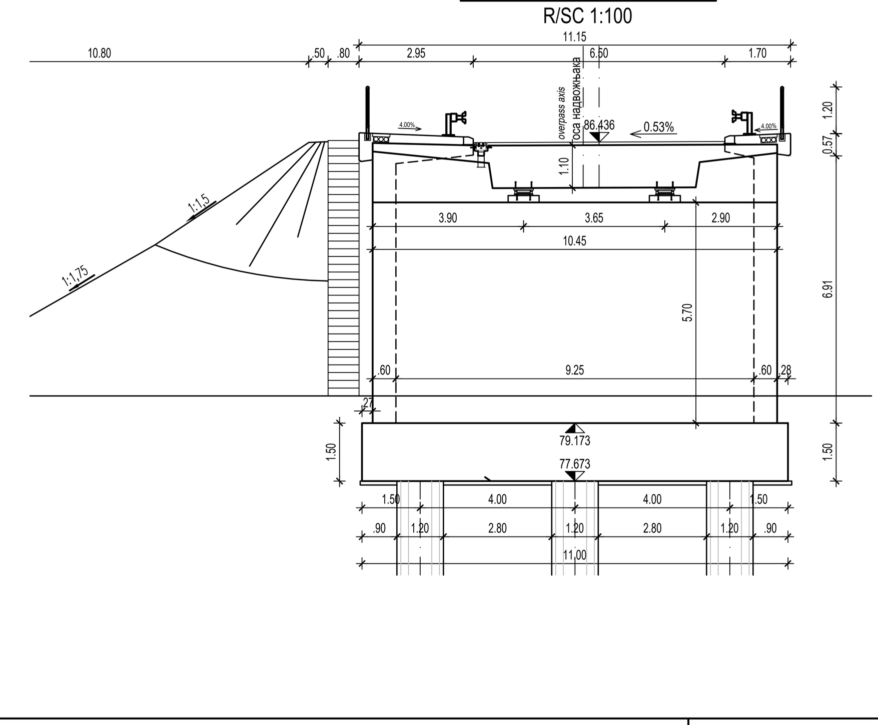
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C11
CROSS SECTIONS AT PIER S11
R/SC 1:100



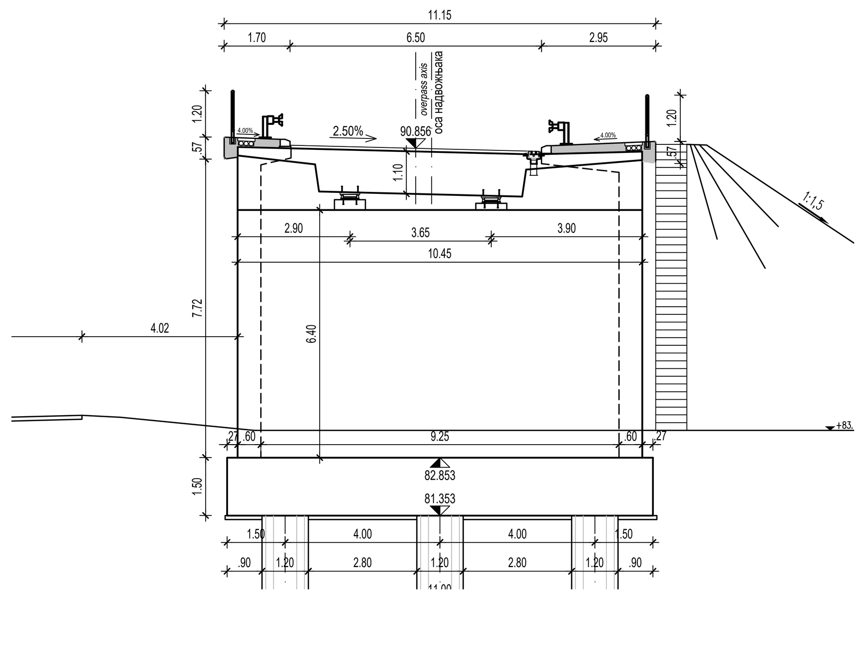
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C12
CROSS SECTIONS AT PIER S12
R/SC 1:100



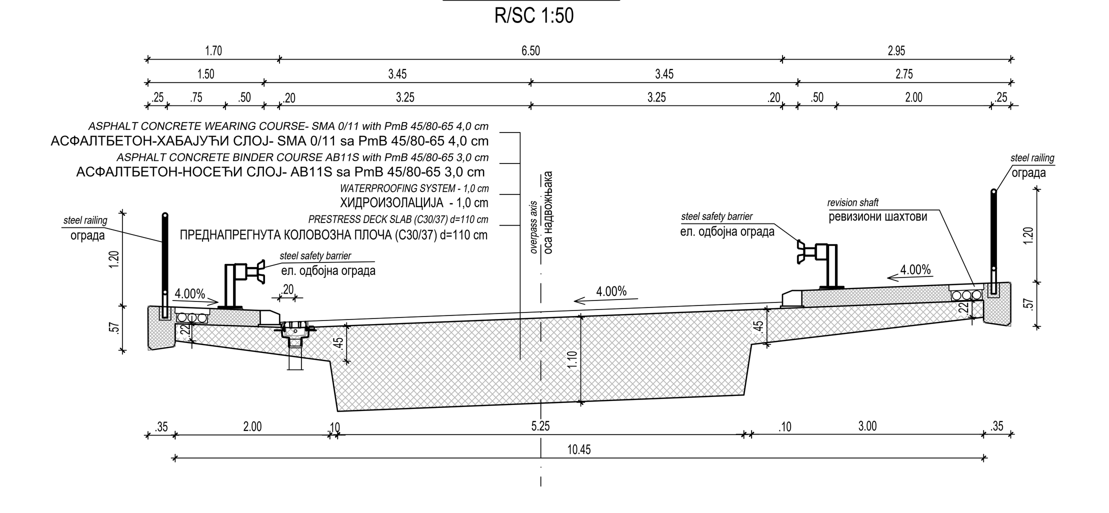
ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C1
CROSS SECTIONS AT ABUTMENTS S1
R/SC 1:100



ПОПРЕЧНИ ПРЕСЕК НА МЕСТУ СТУБА C13
CROSS SECTIONS AT ABUTMENTS S13
R/SC 1:100



КАРАКТЕРИСТИЧНИ ПОПРЕЧНИ ПРЕСЕК
TYPICAL CROSS SECTION
R/SC 1:50



KARAKTERISTIKE MATERIJALA / MATERIALS SPECIFICATION

ELEMENT	Beton/ concrete EN 206-1:2000	Klasa upotrebe/ Exposition class	PV	Betonski čelik/ Concrete steel	Zaštitni sloj/ Concrete cover (cm)
Podbeton/ Lean concrete	C 12/15	X0	/	/	/
Šipovi/ Piles	C 30/37	XC2	PV-I	B500B	min 7.5
Naglavnice/ Pile Caps	C 30/37	XC2	PV-I	B500B	5.0
Obalni stubovi,stubovi i krila/ Abutments, piers and wing walls	C 30/37	XC4, XF1	PV-I	B500B	5.0
Kolovozna ploča/ Deck slab	C 35/45	XC3, XF1	PV-II	B500B	4.0
Prelazna ploča/ Approach slab	C 30/37	XC2	PV-I	B500B	5.0
Pešačke staze/ Walkway and egde beam	C 35/45	XC4, XD3, XF4	PV-II	B500B	5.0
Prednapregnuti kablovi/ Prestressed cables	fpy / fpk = 1670 / 1860 MPa (Ø 15.7 mm)				

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

CRDC China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант: / Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број: / license No.: 310 3032 03

Сарадници: / Associates:
Исидора Гавриловић, дипл.грађ.инж.
Милош Глигоријевић, дипл.грађ.инж.

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
" INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд / Nemanjina Street 6/IV, Belgrade

Наручилац пројекта: / Employer:
China Railway International Corporation Ltd. No.10 Fuxing Road,Haidian District,Beijing P.R China, 100844
China Communication Construction Company Ltd. (CCCC) No.85 Deshengmenwai Street,Xicheng District,Beijing P.R China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.17 Пројекат надвожњака на км 102+309.98
2/1.1.17 Overpass at km 102+309.98

Унутрашња контрола: / Internal control:
Ruan Lidong. Bachelor & Tian Shanpo. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Руководилац организационе јединице: / Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

Цртеж: / Drawing:
ОСНОВА, ПОДУЖНИ И ПОПРЕЧНИ ПРЕСЕЦИ
LAYOUT, LONGITUDINAL AND CROSS SECTIONS

Размера: Scale: 1:200 1:100 1:50

Врста тех. док.: Type of tech. docum.:	датум:/date:	Цртеж бр./Drawing No.:
ПГД / DCP	04.2021.	2020-001-ГС-2/1.1.17.7.Ц01.

ИЗГЛЕД

ELEVATION

KARAKTERISTIKE MATERIJALA / MATERIALS SPECIFICATION					
ELEMENT	Beton/ concrete EN 206-1:2000	Klasa upotrebe/ Exposition class	PV	Betonski čelik/ Concrete steel	Zaštitni sloj/ Concrete cover (cm)
Podbeton/ Lean concrete	C 12/15	X0	/	/	/
Šipovi/ Piles	C 30/37	XC2	PV-I	B500B	min 7.5
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Obalni stubovi,stubovi i krila/ Abutments, piers and wing walls	C 30/37	XC4, XF1	PV-I	B500B	5.0
Kolovozna ploča/ Deck slab	C 35/45	XC3, XF1	PV-II	B500B	4.0
Prelazna ploča/ Approach slab	C 30/37	XC2	PV-I	B500B	5.0
Pešačke staze/ Walkway and egde beam	C 35/45	XC4, XD3, XF4	PV-II	B500B	5.0
Prednapregnuti kablovi/ Prestressed cables	fpy / fpk = 1670 / 1860 MPa (Ø 15.7 mm)				

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

中国铁设 CRDC

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант:
Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број:/ license No.: 310 3032 03

Сарадници: / Associates:
Исидора Гавриловић, дипл.грађ.инж.
Милош Глигоријевић, дипл.грађ.инж.

Унутрашња контрола: / Internal control:
Ruan Lidong. Bachelor & Tian Shanpo. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Руководилац организационе јединице:
Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд / Nemanjina Street 6/IV, Belgrade

Наручилац пројекта: / Employer:
中国铁路国际有限公司 CHINA RAILWAY International Co., Ltd.
China Railway International Corporation Ltd.
No.10 Fuxing Road,Haidian District,Beijing
P.R China, 100844

CHINA COMMUNICATIONS CONSTRUCTION COMPANY LIMITED
China Communication Construction Company Ltd. (CCCC)
No.85 Deshengmenwai Street,Xicheng District,Beijing
P.R China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.17 Пројекат надвожњака на км 102+309.98

2/1.1.17 Overpass at km 102+309.98

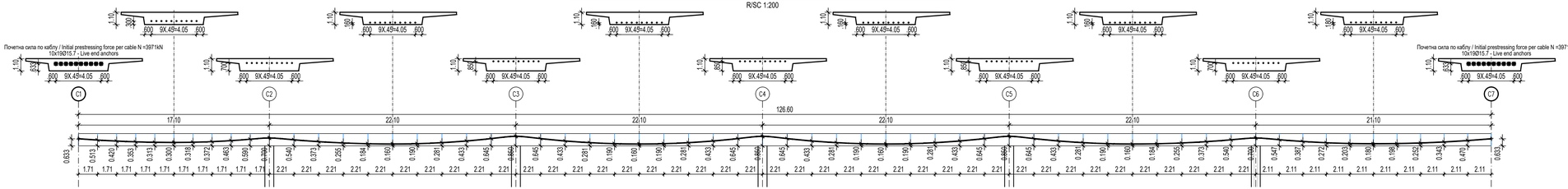
Цртеж: / Drawing:
ПОГЛЕД
VIEW

Размера: Scale: 1:200 1:100 1:50

Врста тех. док.: Type of tech. docum.:	датум:/date:	Цртеж бр./Drawing No.:
ПГД / DCP	04.2021.	2020-001-ГС-2/1.1.17.7.Ц02.

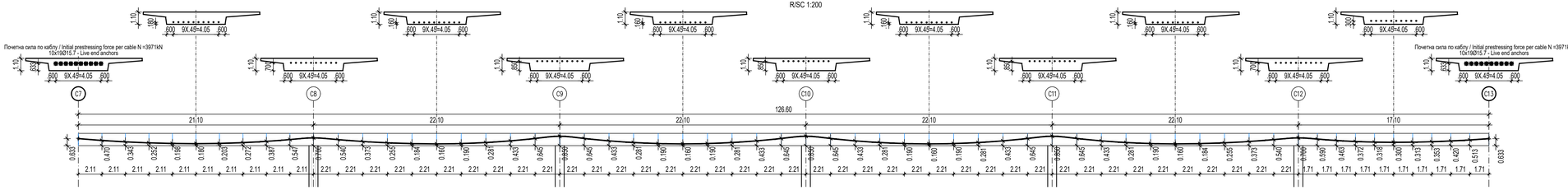
PLAN KABLOVA - PRVA DILATACIONA CELINA / TENDON SCHEMA - FIRST DILATATION UNIT

R/SC 1:200



PLAN KABLOVA - DRUGA DILATACIONA CELINA / TENDON SCHEMA - SECOND DILATATION UNIT

R/SC 1:200



KARAKTERISTIKE MATERIJALA / MATERIALS SPECIFICATION

ELEMENT	Beton/ concrete EN 206-1:2000	Klasa upotrebe/ Exposition class	PV	Betonski čelik/ Concrete steel	Zaštitni sloj/ Concrete cover (cm)
Podbeton/ Lean concrete	C 12/15	X0	/	/	/
Šipovi/ Piles	C 30/37	XC2	PV-I	B500B	min 7.5
Naglavnice/ Pile Caps	C 30/37	XC2	PV-I	B500B	5.0
Obalni stubovi,stubovi i krila/ Abutments, piers and wing walls	C 30/37	XC4, XF1	PV-I	B500B	5.0
Kolovozna ploča/ Deck slab	C 35/45	XC3, XF1	PV-II	B500B	4.0
Prelazna ploča/ Approach slab	C 30/37	XC2	PV-I	B500B	5.0
Pešačke staze/ Walkway and egde beam	C 35/45	XC4, XD3, XF4	PV-II	B500B	5.0
Prednapregnuti kablovi/ Prestressed cables	fpy / fpk = 1670 / 1860 MPa (Ø 15.7 mm)				

Broj/Number	Datum / Date	Opis / Description
03		
02		
01		

Revizioni blok: / Revision block:

China Railway Design Corporation Serbia
Ogranak Beograd
Kosте Racina 166; 11000 Beograd; Srbija

Organizaciona jedinica: GRAĐEVINARSTVO I SAOBRAĆAJ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Odgovorni projektant: / Responsible designer:
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Saradnici: / Associates:
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Investitor projekta: / Investor:
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Nadzornik projekta: / Employer:

China Railway International Corporation Ltd.
No.10 Fuxing Road(middle District),Beijing
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China Communication Construction Company Ltd. (CCCC)
No.85 Deshengmenwai Street,Xicheng District,Beijing
P.R China, 100088

Objekat: /Structure:
PRUGA BEOGRAD - SUBOTICA - DRŽAVNA GRANICA (KELEBIJA)
DEONICA PRUTE NOVI SAD - SUBOTICA - DRŽAVNA GRANICA (KELEBIJA)

BELGRADE - SUBOTICA - STATE BORDER (KELEBIJA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

Deo projekta: / Part of Design:
PROJEKAT KONSTRUKCIJA / DESIGN OF CONSTRUCTION

2/1.1.17 Projekat nadvožnjaka na km 102+309.98

2/1.1.17 Overpass at km 102+309.98

Unutrašnja kontrola: / Internal control:
Ruan Lidong. Bachelor & Tian Shanpo. Bachelor

Glavni projektant: / Chief designer:
dr Ljiljana Milić Marković, dipl.građ.inж.

Rukovodilac organizacione jedinice:
Manager of organization unit:
dr Ljiljana Milić Marković, dipl.građ.inж.

Crtež: / Drawing: PLAN KABLOVA / TENDON SCHEMA

Razmera: Scale: 1:200

Vrsta tehn. dok.: Type of tech. docum.: PGĐ / DCP

Datum/date: 04.2021.

Crtež br. /Drawing No.: 2020-001-ГС-2/1.1.17.7.Ц03.